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Forthcoming Events.

NOVEMBER 20.

West Yorkshire Metallurgical Society:—Discussion on some topics of current metallurgical interest, at Huddersfield.

Sheffield Association of Metallurgists and Metallurgical Chemists:—Ordinary meeting at Sheffield. "Test Bars," Paper by J. Shaw.

Institute of British Foundrymen (Lancashire Branch, Burnley Section):—Ordinary meeting at Burnley. "The Founding of Admiralty Gun Metal and Allied Alloys," Paper by F. W. Rowe.

NOVEMBER 21.

Institution of Production Engineers:—General meeting in London. "The Use of Charts in Engineering," Paper by A. W. Swan, B.A.

NOVEMBER 22.

Birmingham Metallurgical Society:—Ordinary meeting at Birmingham. "X-Ray Analysis of Metals," Paper by Sir W. H. Bragg, K.B.E., F.R.S., D.Sc.

NOVEMBER 25.

West of Scotland Iron and Steel Institute:—Ordinary meeting at Glasgow. "Effects of Time and Temperature on High-Speed and Similar Steels," Paper by W. E. Woodward.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Co-operative Buying.

In a recent conversation with the owner of a small but successful foundry, two strong complaints were made. The first had reference to the continued grumbling by engineers' buyers of the price asked by founders for castings. These buyers complain of the enhanced price now demanded as compared with pre-war figures, but they do not take into consideration *the still greater enhanced price they require for their scrap materials which is a raw material for the foundryman.* Obviously, if the merchant pays a higher price, his percentage of profit roughly remains the same, yielding a still more formidable price to the foundries.

The second complaint is the buying of metals and alloys from the merchants. He gave as a typical case a parcel of 10 tons of a certain alloy which was offered at £80 per ton. He had neither the space nor the liquid money available to store or pay for it, and was only able to take a ton for which he was charged £90. His customer was so satisfied with the castings made from this that a further order was given, necessitating a further 10 cwt. This he secured at £100 per ton.

We have previously pointed out in this column that the buying of non-ferrous metals for foundry work is such that a mistake can ruin a well-conducted foundry whose operating costs are carefully and economically controlled. These conditions are so overwhelming that the small foundry owner's time and thought are being dissipated in this direction instead of being devoted to production and quality considerations. Though associations of the trade exist they do not give the consideration to this subject that its importance warrants. Members of such bodies are constantly in conversation, pointing out with a certain amount of pride how they picked up this or that parcel at a low figure. However, they do not enlarge upon the fact that they had to take more than they really wanted, or that the market has chanced to go in their favour, or the feeling of thankfulness they experienced when the bank granted the accommodation, or the unpleasant efforts they since have to make to obtain extended credits from other suppliers.

The remedy for all this is in their own hands. They should through existing or fresh associations create a co-operative buying department. This department would receive all inquiries from its associated concerns together with a price range as conditions warrant, the quantity required, the origin of the contract, so that no double buying could take place. A co-operative laboratory could well pay for itself in this connection. The merchant need not be driven out of business, especially if he does real work, such as the grading of the scrap. He would not be driven to ask prices which include a cover for bad debts, as he would be much more sure of payment. Competition would still be maintained, as foreigners buy heavily on occasion in the British market. Additionally, there should be district and not national associations formed.

The engineer, who is the eventual consumer, would benefit by more stable prices, for it is no real gain to him to receive goods at a price which renders unlikely the continuation of the source of supply.

German Views on Semi-Steel and other High-Grade Low-Carbon Cast-Irons.*

By F. Wust and P. Bardenhener.

Melting in a Crucible.

The strength of grey cast iron depends primarily on the quantity and form of the uncombined carbon. This connection or interdependence has been shown by Wüst and Kettenbach's experiments on test melts containing varying quantities of carbon and silicon. The melts were made in graphite crucibles, using pure materials. It was found that the transverse strength, tensile strength and hardness decreased with increase of the graphite content. The transverse strength, which is 50 to 65 kg. per sq. mm. with a graphite content of 1.3 per cent., drops to 20 kg. per sq. mm. when the graphite content is doubled. Between the same limits of graphite content the tensile strength decreases from 20 to 30 kg. or sq. mm. to 7 to 8 kg. per sq. mm., and the Brinell hardness from between 240 and 280 to 120. By increasing the percentage of carbon and silicon the graphite in the material is coarsened. In the semi-steel samples the graphite was present in the form of nodules. Table I gives the analyses and strength figures of a number of casts of what may be regarded as high-grade cast iron. These figures will show the importance of the total carbon content. If this latter figure be moderate, even a high silicon content cannot precipitate sufficient graphite appreciably to affect the strength adversely (casts Nos. 1, 2 and 21). Other melting tests show that, where the carbon content is high, a low silicon content cannot prevent extensive precipitation of graphite and a decrease in the strength of the material.

When making use of these results in practice, the effect of other admixtures, especially manganese, phosphorus and sulphur, must be borne in mind, as these may easily displace the limits of the favourable effects of carbon and silicon.

The tests carried out by the above workers show also that a further improvement in the strength values is effected by increasing the manganese content. The effect of manganese is apparent from a comparison of the figures in series I, Table II and Table 1. Test series II shows that an increased manganese content permits the increase of the carbon content to slightly more than 3 per cent. of the strength of the material still further increasing in spite of the high graphite content.

Table I.—*High-grade Crucible Cast Iron (Wüst and Kettenbach).*

Melt No.	Total Carbon. %	Graphite. %	Combined Carbon %	Si %	Mn %	P %	S %	Tensile Strength. Tons sq. ins.	Transverse. Tons sq. ins.	Deflection in ins.	Brinell hardness.
1	2.00	1.02	0.98	2.19	0.12	0.063	0.011	16.83	20.92	0.324	323
2	2.40	1.15	1.25	2.91	0.13	0.068	0.012	17.84	26.35	0.336	327
8	2.90	1.40	1.50	1.14	0.13	0.077	0.012	17.46	33.21	0.448	285
9	2.60	1.08	1.52	1.73	0.12	0.078	0.009	15.64	30.85	0.352	305
21	2.56	1.45	1.11	2.25	—	—	—	14.86	33.91	0.472	246
22	2.62	1.25	1.37	1.26	—	—	—	17.15	36.77	0.48	248
24	2.90	1.25	1.65	1.18	—	—	—	18.42	33.91	0.452	244
25	2.86	1.46	1.40	1.55	—	—	—	15.75	35.43	0.388	236

Table II.—*High-grade Crucible Cast Iron (Wüst and Meissner).*

Test Series	Melt No.	Total Carbon. %	Graphite %	Combined Carbon. %	Si %	Mn %	P %	S %	Tensile Strength. Tons sq. in.	Transverse. Tons sq. in.	Deflection in ins.	Brinell hardness.
I.	5	2.80	2.15	0.65	1.53	0.71	0.031	0.003	20.76	36.77	0.804	213
	6	2.74	1.95	0.79	1.71	0.79	0.041	0.006	20.64	36.88	0.704	214
	7	2.90	2.12	0.78	1.57	0.93	0.030	0.003	20.32	38.16	0.640	235
	8	2.79	2.15	0.64	1.54	0.96	0.029	0.007	21.59	37.85	0.664	221
	9	2.97	2.25	0.72	1.55	1.34	0.026	0.005	20.32	36.26	0.668	217
	10	2.92	2.22	0.70	1.59	1.55	0.029	0.004	16.89	33.34	0.388	227
II.	14	2.98	2.40	0.58	1.57	0.65	0.075	0.009	22.16	38.23	0.936	200
	16	3.01	2.36	0.65	1.45	0.80	0.064	0.013	22.16	38.16	0.800	202
	17	3.07	2.30	0.77	1.43	0.98	0.061	0.008	21.91	38.74	0.820	209
	18	3.08	2.28	0.80	1.39	1.20	0.064	0.014	22.56	39.56	0.744	215
	19	3.11	2.33	0.78	1.45	1.41	0.057	0.011	23.01	35.95	0.696	222
	20	2.98	2.10	0.88	1.49	1.71	0.062	0.010	18.61	30.04	0.340	240

Table III.—*High-grade Cast Iron by Mixing Liquid Steel and Pig-Iron.*

Test Series.	Total Carbon. %	Graphite. %	Combined Carbon. %	Si %	Mn %	P %	S %	Tensile Strength. Tons per sq. in.
I. Average	2.06	1.60	0.43	1.38	0.56	0.94	0.081	8.89
II. Average	2.44	1.93	0.50	1.91	0.45	1.96	0.097	13.78
III. Average	2.33	1.62	0.71	1.50	0.40	1.10	0.10	12.83
IV. Average	2.55	2.20	0.32	1.81	0.56	0.83	0.08	17.40

The favourable effect of manganese commences to decline as soon as its content exceeds 1.4 per cent. (cast Nos. 10 and 20). Speaking metallographically, the effect of the manganese is explained by the fact that the quantity of mixed crystals primarily deposited increases with increased manganese percentages, the graphite being necessarily precipitated in a finely divided state. With increase in the manganese content, the free ferrite is quickly segregated from the structure, the groundmass consisting only of pearlite.

According to Wüst and Stotz, phosphorus up to 0.3 per cent. has a favourable effect on cast iron. A high percentage of phosphorus is not desirable, especally in low carbon cast iron, as it may easily prevent entirely the formation of graphite.

The results of the investigations carried out show the favourable composition for high-grade

* Translated from Die Giesserei.

cast iron to be:—C, 2.5 to 3.1; Si, 1.2 to 2.2; Mn, 0.7 to 1.2, and P, 0.3 per cent.

Mixing of Liquid Steel and Liquid Pig-Iron.

As far back as 60 years ago Henry Bessemer, and 40 years later, A. Zenzes, obtained high-grade cast iron by this process. The following are some results obtained from tests on high-grade cast iron produced by this process:

The pig-iron used was obtained from the cupola furnace, the steel being blown in a 2-ton Bessemer converter from cupola metal. The best strength was obtained with the 25 per cent. steel addition. The casting temperature of this mixture was 1,380 to 1,400 deg. C. The best proportions for the alloy were ascertained by four series of tests with

Melting in an Open-Hearth Furnace.

Test melts with this system have been carried out by a German firm (Meir & Weichelt, Leipzig-Lindenau). The initial material, a crude malleable cast iron was placed in the acid Siemen's furnace until it had attained the necessary carbon content, and then mixed in a crucible (at high temperature) with the necessary ferro-silicon and ferro-manganese. From each test cast two bars each of 30, 25, 20 and 15 mm. dia. were obtained from the same ladle. The results of the chemical and physical tests are recorded in Table IV. The transversing strengths and deflections were obtained on test pieces on which the "skin" still remained, and with a distance between supports of L=20D. Cast No. 6, with the lowest carbon

TABLE IV.—*High Grade Cast Iron from the Open Hearth Furnace.*

Cast No.	Casting ° Temp.	Bar ins.	Total carbon.	Graphite. Per cent.	Combined Carb. p.c.	Si. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.	Transverse. Tons per sq. in.		Deflection. Ins.		Tensile strength. Tons per sq. un.		Impact strength. Ft. lbs. per sq. in.		Brinell hardness.	Specific gravity. upper	Specific gravity. lower
		1.2		1.85	1.09					31.62	30.99	0.432	0.412	12.13	12.45	29.39	28.69	225	7.255	7.257
										31.23		0.392		12.76		27.99			7.256	7.255
		1.0		1.85	1.09					32.70	31.69	0.356	0.348	15.68	15.30	26.93	27.29	234	7.257	7.254
										30.61		0.340		14.92		27.78			7.254	7.258
4	1320	0.8	2.94	1.74	1.20	2.70	0.38	0.09	0.065	33.97	33.78	0.276	0.272	15.05	14.29	23.80	23.56	243	7.258	7.257
										33.59		0·268		13.46		23.28			7.255	7.256
		0.6		1.69	1.25					34.74	34.74	0.180	0.188	—	13.46	23.05	22.58	258	7.257	7.258
										34.74		0.192		13.46		22.11			7.255	7.256
		1.2		1.83	1.27					27.75	34.55	0.280	0.448	16.07	16.00	39.75	41.94	214	7.348	7.347
										34.55		0.448		15.88		44.13			7.350	7.353
		1.0		1.83	1.27					35.56	34.62	0.396	0.380	18.42	17.78	35.17	32.42	230	7.351	7.334
										33.72		0.360		17.15		29.62			7.348	7.361
5	1290	0.8	3.10	1.65	1.45	1.48	0.32	0.089	0.056	38.87	37.78	0.310	0.304	19.75	18.73	23.33	24.63	240	7.333	7.343
										36.13		0.288		17.72		25.69			7.342	7.340
		0.6		1.56	1.54					29.59	36.00	0.160	0.208	18.80	18.54	19.78	16.50	251	7.352	7.349
										36.00		0.208		18.22		20.43			7.348	7.350
		1.2		1.70	1.22					37.27	35.75	0.512	0.476	15.43	16.50	44.08	42.40	234	7.347	7.349
										34.33		0.440		17.59		40.68			7.348	7.351
		1.0		1.77	1.15					36.64	34.93	0.380	0.364	17.97	18.16	26.50	29.86	235	7.350	7.347
										33.15		0.344		18.35		33.21			7.348	7.349
6	1355	0.8	2.92	1.64	1.28	1.43	0.37	0.109	0.072	36.64	36.39	0.280	0.280	19.75	18.73	23.60	25.10	239	7.354	7.350
										36.13		0.280		17.72		26.50			7.351	7.349
		0.6		1.62	1.30					38.10	36.45	0.204	0.200	18.22	18.03	22.86	21.69	250	7.366	7.354
										34.74		0.192		17.78		22.86			7.358	7.361
		1.2		1.79	1.35					33.53	34.16	0.424	0.432	15.24	15.94	37.09	39.28	220	7.338	7.341
										34.74		0.440		16.56		41.47			7.340	7.337
		1.0		1.79	1.35					35.88	34.55	0.360	0.348	18.22	18.42	35.17	32.33	235	7.338	7.341
										33.15		0.336		18.61		29.62			7.335	7.339
7	1345	0.8	3.14	1.78	1.36	1.49	0.37	0.095	0.088	33.97	33.91	0.268	0.264	16.63	17.01	26.59	25.24	236	7.340	7.341
										33.85		0.256		17.40		23.88			7.336	7.342
		0.6		1.73	1.41					28.77	30.61	0.188	0.192	19.05	18.42	21.22	20.62	247	7.338	7.339
										32.39		0.200		17.15		20.95			7.341	7.336

TABLE V.—*Vogl's Experiments with High-Grade Cast-Iron in Electric Furnace.*

Cast No.	Total C. Per cent.	Graphite Per cent.	Combined C. Per cent.	Si. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.	Transverse Tons per sq. in.	Deflection. Tons per sq. in.	Tensile Strength. Tons per sq. in.	Brinell Hardness.
604	3.01	2.31	0.70	2.25	0.33	0.027	0.019	32.25	8.38[1])	19.69	209
759	2.82	2.04	0.78	2.13	0.28	0.030	0.017	33.65	8.00[1])	20.57	232
759	2.90	2.11	0.79	2.22	0.29	0.029	0.016	36.07	10.09[2])	21.08	230
1,078	3.05	2.38	0.67	1.66	0.34	0.026	0.008	35.43	9.78[1])	22.35	209
1,078	3.06	2.42	0.64	1.67	0.33	0.026	0.008	35.47	11.58[2])	21.38	204

different types of cast iron. The analyses and strength figures are given in Table III. In series 2 the high silicon content resulted in a considerable increase in strength, in spite of extensive graphite precipitation. In test series 3 (Table III) the phosphorus content was raised at the expense of the silicon, due to the larger addition made of Luxembourg No. 3 for the purpose of saving hematite pig. As a result, the strength of the material underwent a slight decrease. In series 4 (Table III) an average strength of 17.4 tons per sq. in. was recorded, the silicon content of the metal being higher and the phosphorus and sulphur contents not too high. The micro-examination of this material also revealed a pearlitic ground-mass interspersed by finely divided graphite and phosphide eutectic. This process can only be carried out satisfactorily when the mixed iron is very hot.

and silicon contents, has the highest transverse strength. With decrease in bar diameter and decrease in graphite content an increase in transverse strength is generally recorded. The tensile strength was determined on bars with a length of five times the diameter. The diameter was 4-5ths of the original. Cast No. 4, having the highest silicon content, exhibits the lowest tensile strength. In every case the micro-examination revealed a fine distribution of the graphite; in fact, the smaller the diameter of the bar the finer the graphite. The ground mass is again in all cases lamellar pearlite, which must be taken as characteristic of the structure of high-grade cast iron.

Melts Made in the Electric Furnace.

H. Vogl recently published a paper on some experiments carried out by him on material made in the Héroult electric furnace. He found the

electric furnace to be specially suited for the production of high-grade cast iron. The charge consisted exclusively of steel scrap carburised by "carburite."* In Table V are shown some results of chemical and physical tests carried out on a few casts having a low carbon content. The very low sulphur content is worthy of note. The micro-examination of the material again showed in all cases a fine distribution of the graphite and a purely pearlitic ground-mass. In addition to the direct electric process, the duplex process is being used for making high-grade cast iron, the actual production taking place in the cupola furnace and the refining of the material in the electric furnace.

Casts Made in the Cupola.

High-grade cast iron is made in the cupola by an old and reliable process, low-carbon cast iron being used. C. Henning uses, in addition, an intermediate product obtained by mixing liquid steel and pig-iron. Table VI. contains a few of the test figures obtained by Henning. This material is characterised by an extraordinarily fine grain, and no graphite nodules were visible on the smooth, machined surface.

A satisfactory and uniform product can also be made by the direct addition of steel scrap in the cupola furnace, provided certain precautions are observed. Among the several difficulties likely to be encountered in working with this process, the following should be mentioned:

1. Low-carbon steel requires a higher temperature to melt it and a greater quantity of foundry coke, and this favours the absorption of sulphur.

2. In view of the fact that the absorption of carbon depends greatly on the temperature of the furnace and on the rate at which the process is carried out, any disturbances in the normal process of the heat adversely affect the uniformity of the carbon content of the material. Steel scrap in small pieces easily drops through the rest of the charge, and dropping on to the hearth is likely to give rise to zones in the metal which are poor in carbon and silicon. Heavy pieces of mild steel scrap lead to the same trouble.

3. Steel scrap, especially thin sheets or turnings, burns up very quickly, and the resultant oxides lead to the formation of blow-holes in the castings.

A reference to the literature of the subject shows that the direct process had been introduced on a large scale in America in recent years, and with good results provided the difficulties just mentioned are properly overcome. Table VII contains the analyses and mechanical test results of "semi-steel," as reported by various authors.

To sum up: The essential characteristics of high-grade cast iron may be said to be a fine distribution of the graphite and a purely pearlitic ground-mass. This structure is attained with a low carbon and silicon content and a high manganese content.

* A briquetted Mixture of Carbon and Turnings.

TABLE VI.—*Cupola High-Grade Cast Iron (Henning)*

No.	Total C. Per cent.	Combined C. Per cent.	Si. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.	Tensile Strength Tons per sq. in.	Casting.
1	3.43	1·00	1.25	0.60	0.97	0.165	15.24	Loco cylinder.
2	3.36	0.91	1.05	0.65	0.82	0.147	16.19	"
3	3.43	0.99	1.09	0.94	0.79	0.134	15.43	"
4	3.34	0.78	1.00	0.88	0.71	0.102	15.30	"
5	3.57	0.79	1.17	0.66	0.83	0.103	15.24	"
6	3.36	0.71	1.07	0.69	0.82	0.116	15.05	"
7	3.25	—	1.39	0.64	0.79	0.156	15.37	"
8	3.28	—	1.31	0.62	0.82	0.146	15.94	"
9	3.13	—	0.58	0.58	0.57	0.104	—	For Hydraulic Press.
10	3.19	—	0.60	0.62	0.60	0.141	17.34	Table for Hydraulic Press; wall thickness 40-50 mm.

TABLE VII.—*High-grade Cast Iron from Cupola (Direct Process as per American Authors).*

Author.	Added Steel %	Total C %	Graphite %	C %	Si %	Mn %	P %	S %	Bending Strength. Tons sq. in.	Tensile Strength. Tons sq. in.
H. Field [1]	10	3.25	2.90	0.45	2.00	0.60	1.00	0.110	26.67	14.29—15.24
	20	2.40	2.90	0.50	1.80	0.70	0.85	0.125	30.61	17.01—17.91
Y. A. Dyer [2]	15.0	3.81	—	—	1.86	0.86	0.430	0.070	25.40	—
	12.5	3.43	—	—	1.77	0.49	0.339	0.069	25.08	14.48
	30.0	3.25	—	—	1.65	0.47	0.450	0.070	28.89	16.75
	35.0	3.20	—	—	1.33	0.45	0.194	0.121	26.67	—
	35.0	3.20	—	—	1.35	0.45	0.208	0.121	27.31	—
	25.2	3.22	—	—	1.04	0.76	0.100	0.118	28.58	—
	21.9	3.11	—	—	1.61	1.10	0.120	0.119	30.48	—
	23.3	2.86	—	—	1.43	0.58	0.112	0.110	36.20	—
	33.0	2.84	—	—	1.10	0.64	0.108	0.109	37.78	—
F. E. Hall [3]	25.2	3.22	2.57	0.65	1.04	0.76	0.100	0.118	—	15.88
	24.8	3.22	—	—	1.15	0.72	—	—	—	14.86
	24.8	3.22	2.60	0.62	1.01	0.80	0.080	0.101	—	17.15
	24.4	3.14	2.54	0.60	1.37	0.80	0.094	0.107	—	15.24
	24.8	3.13	2.50	0.63	1.26	0.81	0.092	0.104	—	16.82
	30.4	3.00	2.35	0.65	1.09	0.55	0.111	0.121	—	15.62
	33.0	2.84	2.13	0.71	1.10	0.64	0.108	0.109	—	20.51
	23.5	3.06	2.42	0.64	1.40	0.70	0.102	0.095	—	18.42
	23.4	2.99	2.32	0.67	1.01	0.66	0.118	0.100	—	18.48
	23.3	2.96	2.49	0.47	1.43	0.58	0.112	0.110	—	20.51
	32.8	3.02	2.36	0.46	1.28	0.60	0.104	0.123	—	21.84
	33.1	3.01	2.35	0.66	1.07	0.61	0.120	0.111	—	21.08
	23.5	3.06	2.45	0.61	1.38	0.72	0.102	0.102	—	14.67
	33.2	2.81	2.09	0.72	1.06	0.60	0.106	0.118	—	19.37
	21.9	3.11	2.51	0.60	1.61	1.10	0.120	1.119	—	16.88

[1] FOUNDRY TRADE JOURNAL. 23 (1921), P. 201. [2] "Iron Age," 107 (1921), P. 9. [3] "Foundry," 48 (1920), P. 160.

THE works at Brimsdown, Middlesex, of the London Foundry Company, Limited, are being offered for sale by tender. The offer comprises about 23½ acres of land, and the foundry buildings, with an area of 53,800 sq. ft. The equipment includes two 10-ton cranes, three electric furnaces, etc., for an output of 200 tons of steel castings per week.

J. HINCKLEY & SON, iron and steel merchants, of Sheffield, who are agents for the sale of the pig-irons, ores and alloys, of the Darwen & Mostyn Iron Company, Limited, Pease & Partners, Limited, and A. Johnson & Company, Stockholm, inform us that their Mr. H. Hinckley, who for some years has been their representative in the Birmingham district, has now taken up his residence in that district to facilitate the work of the firm's business.

The Foundries of Messrs. John Cockerill et Cie.

The new foundries of Messrs. John Cockerill & Company, of Seraing, Belgium, which were finished in 1920, cover a rectangular area of about 220 by 175 yds. The actual moulding area is 15,550 sq. yds., of which 8,550 is devoted to cast-iron, 6,640 to steel, and 750 to brass.

The Iron Foundry.

The iron foundry comprises a central bay 65 ft. wide by 262 ft. long, and is spanned by three over-

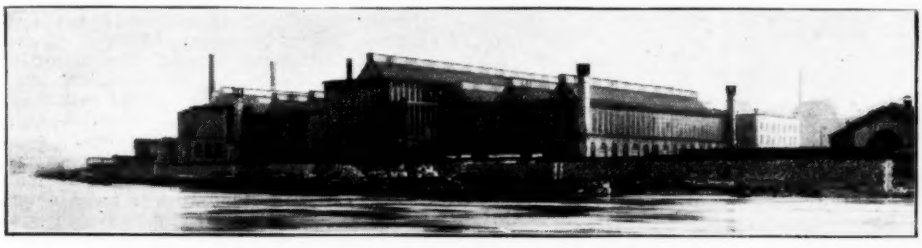

FIG. 1.—GENERAL VIEW OF THE FOUNDRIES. THE CUPOLAS ARE AT THE FAR END OF THE PROLONGED CENTRAL BAY. MESSRS. JOHN COCKERILL ET CIE, SERAING.

head travelling cranes, two of which are of 75 tons capacity and one of 25 tons, and ten other bays 147 ft. long by 49 ft. wide, which are served by numerous cranes of 25 to 50 tons capacity. Moulding and coremaking is carried on in each of these bays. At one end of the central bay five cupolas are installed, one of which has an output of 10 tons per hour, two of 8 tons, and two of 5 tons. They are fed by an electric lift of 25 tons capacity, the cupola staging having an area of 478 sq. yds. Under this platform the repair of ladles is carried out, a 10-ton crane being installed for this purpose.

The blast is generated by two electrically-operated blowers of 115 and 75 h.p. respectively, the latter acting as a stand-by.

At one side of the central bays are five lateral bays, the first of which is exclusively devoted to ingot-mould manufacture, the second to loose-pattern moulding, and the three others to loam moulding. On the other side of the central bay, the corresponding bays are used for small castings, three for loose-pattern and strickle moulding and the last one as a core shop. Both jar ram and pressure machines are included in the moulding machine equipment. Gas-engine bed plates, weighing up to 60 tons, are a regular feature of the output, and castings weighing up to 120 tons can easily be handled. At the end of the lateral shops, 12 drying ovens are installed which have a usable area of 600 sq. yds.

The central bay juts out beyond the rest of the building to include the fettling shop and despatch stores. These two departments cover an area of 1,913 sq. yds. An annexe to the fettling shop houses an air compressor for supplying compressed air for cleaning purposes, the gas and electric welding plants, and at the side of the dressing shop a number of annealing ovens for heat treating steel castings are installed.

Steel Foundry.

The moulding for steel castings is carried out in two shops, one being 285 ft. long × 52 ft. wide, and the other 220 ft. × 52 ft. The two shops are well served by cranes, having between them a 50-ton with a 10-ton auxiliary, and three 25-tons with 5-ton auxiliary hoists. As with the iron foundries, there are a large number of moulding machines installed. Metal is melted in two electrically-charged Siemens furnaces, one of 20 and the other

FIG. 2.—THE IRON FOUNDRY SHOWING THE CENTRAL BAY, WITH THE CUPOLAS AT ITS END AND EIGHT OF THE TEN SIDE BAYS. MESSRS. JOHN COCKERILL ET CIE, SERAING.

of 30 tons capacity, supplemented by a 15-ton Héroult furnace. Castings up to 50 tons weight are made.

Brass Foundry.

Near to the steel foundries is a shop measuring 59 ft. × 115 ft., served by a 4-ton and a 2½-ton cranes, forms the brass foundry. Melting is conducted in Morgan and Potazer furnaces. Machine moulding is largely practised, and castings weighing up to 5 tons can be made.

Pattern Shops.

Situated above the fettling-shop annexe, the pattern shop is well equipped with all modern machinery and tools and is spanned by a 5-ton crane. Its dimensions are 230 ft. × 50 ft.

D

Sand Preparing.

Situated at floor-level, the sand-preparing shop has an area of 460 sq. yds., and contains a battery of mills and finished sand bins. A large staging of 544 sq. yds. carries the balance of the plant, such as the raw-sand bins and the driers, and is served by a 6-ton capacity monorail.

The first-aid station, pay office, and general stores cover an area of 1,350 sq. ft.

Repair Shop.

Replete with numerous modern machine tools, the repair department occupies an area of approximately 5,000 sq. ft. and the shop is spanned by a 20-ton overhead crane. In an annexe there are installed the compressors and pumps for the general water supply. The test house is also situated in the annex.

In conclusion, it can be stated that every shop is supplied with running water and compressed air in such a manner that the latter can be easily connected to all the pneumatic and moulding machines, forging tool hammers, pneumatic hammers, chisels installed in the trimming shop and iron, steel and brass foundries.

New Research Laboratory and Lecture Room at Birmingham.

SIR ROBERT HADFIELD, BT., as briefly reported last week, opened the new research laboratory and lecture room of the Municipal Technical School, Birmingham, of which the Principal is DR. W. E. SUMPNER, D.Sc., and in which as regards chemistry the work is carried on by DR. J. NEWTON FRIEND.

SIR ROBERT, in the course of an address, remarked that the works laboratory differed from the technical school laboratory in that the former should turn out results, whilst the school laboratory should turn out men properly trained to obtain these results. The study of corrosion was a most fascinating one—at times the results were so elusive that there was very little or nothing left to get hold of. Much of the research work of to-day was in the direction of producing something new, something which we had not had before, whereas the study of corrosion meant the careful watching of something which was vanishing and disappearing from our view. It is most difficult even to estimate when iron was first produced in the world, its origin was lost in dim antiquity; but whenever the first appearance did take place, oxygen, which was so plentifully provided by nature, at once commenced its work of corrosion.

When speaking of corrosion, it might be interesting to refer to a specimen of the sheet iron used in the first gasometer, erected in 1792 by Murdoch, the originator of gas lighting. This gasometer only a few years ago was in service at the works of Messrs. W. & T. Avery, Ltd., Birmingham, for the storage of gas, and was interesting as an example of the longevity of even thin sheet-iron when kept suitably protected by painting. An analysis of the iron used in the construction of this gasometer showed the composition:—C 0.04, Si 0.28, S 0.045, P 0.550, Mn 0.07, Cu 0.02, Fe 98.9 per cent. The total impurities in the iron, that was, C, Si, S, P, Mn, and Cu, amounted to 0.99 per cent., which hardly brought it under the category of "pure iron," yet as already mentioned the gasometer in question was at work until quite recently, satisfactorily resisting the corrosive effect of wind and weather. As he (Sir Robert) had pointed out in his Paper, read before the Institution of Civil Engineers, early last year, it was probable that there was an annual loss to the world by corrosion of at least £500,000,000 each year, therefore any means of entirely avoiding this, which was too much to expect, or reducing this, which was quite practicable, should be encouraged in every possible way. Hence the importance of the laboratory which had been opened that day.

CHUBB & SON'S LOCK AND SAFE COMPANY, LIMITED, have established a Central London branch at 39, Aldwych, W.C.2.

Book Review.

Practical Moulding, by S. Jones Parsons, M.I.Mar.E. Published by Messrs. George Routledge & Company, Limited, Broadway House, 68, Carter Lane, London, E.C.4. Price 5s. net.

This book is ideal for teaching purposes. The 124 illustrations are very neat and clear. In criticising books of this character it is always easy to say that it is not up-to-date—that it contains no reference to the hydraulic or sand slinging systems of moulding, or that insufficient stress is laid upon semi-steel, and so forth—but perhaps authors are of opinion that if they give the groundwork, and it is thoroughly digested by the student, sufficient knowledge has been gained critically to follow his studies in any direction appertaining to his work. We sympathise with any writer of foundry literature, for it is extremely difficult to visualise how much his readers know of allied subjects. In this case the author assumes no knowledge of chemistry or metallurgy, and arithmetic up to the decimal system.

In Chapter 2 some loose expressions exist which require elimination or amendment in the next edition. For instance, when speaking of the elements which are part and parcel of the make-up of a cast iron, the author correctly states "that the term impurities is arbitrary," but that "they are better known in foundry work as *metalloids*," that is, non-metallic elements having the appearance of metals. He points out that the most important of these elements are *carbon*, *silicon*, *sulphur*, *phosphorus* and *manganese*. Actually, there is only one metalloid present which is silicon. Manganese is definitely metallic, and carbon, phosphorus, and sulphur are non-metallic, though by some stretch of the imagination carbon, in one of its allotropic modifications might be regarded as a metalloid. Another loose statement is that "carbon in cast iron is practically identical with graphite or black lead." It should read, of course, that one form in which carbon exists in cast iron, etc. Whilst this is obvious to the qualified foundryman, it may not be so for the apprentice, and we have assumed that it is for this type of reader that the book is designed to interest. However, the few loose statements which exist scarcely detract for the practical value of the book, for unless a foundryman does, as the author suggests in his preface, study chemistry and metallurgy, he will only have the very haziest notions of the effects of the various elements upon cast iron.

In conclusion, the experienced foundry manager or foreman need have no hesitation in bringing this book to the notice of his moulders and apprentices.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Bribery in the Foundry.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—There is another method of preventing bribery, and that is to co-operate with the Bribery and Secret Commissions Prevention League, Incorporated, which was formed for the purpose that its name suggests. It was the League that prosecuted in the "pot money" case to which you refer, but the Council attaches most importance to educating public opinion, and prosecutions are only a means to an end. The League has accumulated a good deal of experience, and it is always ready to advise persons whether or not they are members. I shall be pleased to send further particulars to any of your readers.—Yours, etc.,

THE SECRETARY,
Bribery and Secret Commissions Prevention League, Incorporated,
9, Queen Street Place, London, E.C.4.

THE ANGLO-AMERICAN OIL COMPANY have placed an order with James Pollock, Sons & Company, Limited, for a steel screw coasting tanker of 115 tons d.w., fitted with a 135-b.h.p. Bolinder heavy oil engine with several special features, including electric starting.

An Apprenticeship Course in Foundry Practice.—LXIV.

By Ben Shaw and James Edgar.

BRASSES AND BRONZES.

The work in the brass foundry usually embraces all non-ferrous metals and alloys. Thus, white either brass or bronze may form the major part of the work it is not limited to these alloys, but white metal and aluminium alloys may be dealt with. Of recent years, however, owing to the rapid progress made in various branches of engineering, necessitating castings having aluminium as the base metal, the production of aluminium castings is gradually becoming a specialised foundry industry. Many foundries now concentrate entirely on aluminium work excluding all other non-ferrous work. White metals have long been associated with the work of the brass foundry, but while the work done is important, it forms but a minor part. In this article, therefore, we purpose confining ourselves to those alloys that are required for the more general work of the brass foundry.

Brass.

The term brass is frequently used to embrace all the alloys of copper. This is, no doubt, due to the fact that in ancient times the alloys that we now represent as bronzes or indeed any of the alloys of copper were all referred to as brasses. This term, however, is now more particularly applied to alloys of copper and zinc, but it is also applied to other alloys of which copper and zinc form the principal ingredients, other metals that may be present being relatively small.

In a general sense the colour of brass is yellow, varying in shade according to the proportions of copper and zinc. It is harder than copper, and, according to the composition, has considerable tensile strength. Some alloys, like manganese bronze or better manganese brass, have a tensile strength approaching that of steel. Brass is readily cast and machines satisfactorily. Within certain limits in the composition brass has a fine close texture. Thus between compositions containing 90 copper, 10 zinc and 67 copper and 33 zinc, the fracture shows a fine texture, whereas other compositions of copper and zinc in which copper predominates have a relatively coarse fracture. The melting point of these alloys varies according to the percentages of their constituents, being generally higher with a greater percentage of copper, the temperature closely approximating to the mean melting temperature of the constituents. Thus while the mean melting temperature of copper is near to 1,085 deg. C., and that of zinc 420 deg. C. the melting point of a naval brass consisting of 61.5 copper, 37 zinc and 1.5 tin is approximately 855 deg. C. Some of the brasses are malleable and ductile, particularly that known as Muntz metal, consisting of 60 per cent. copper and 40 per cent. zinc.

Mixtures for Brass.

Many alloys that are classed as brasses are given, together with their constituents, in Table I. Some are of recognised standard composition. While these mixtures are offered as a guide to the apprentice it must be remembered that almost every manufacturer specialising in brass work, as well as brass founders, have their own special mixtures which they prefer for certain purposes and which they consider to be superior to other compositions, either from the point of view of economy or because of some real or imaginary quality they are considered to possess.

The red brasses are used for castings that are to withstand high pressures such as valves and pipe fittings. They are also used for ornamental work, the reddish colour being intensified by pickling the castings. The ordinary red brass corresponds to quarter metal, but tin and lead are generally added in varying proportions, usually with a view to facilitating machining. In some instances the lead content is increased to 10 per cent. for use in the production of inexpensive bearings or for low pressure valves and fittings. The English brass is the composition suitable for rolled and forged work and is used to a considerable extent for condenser tubes, but it is also used for high-class brass fittings. The Admiralty standard mixture for condenser tubes, by the way, contains a small percentage of tin, 70 copper, 29 zinc and 1 tin, being the composition. Invariably there is present a small amount of lead and iron in the composition. The ordinary 66-34 composition is used for much general work that does not require much strength, and is not subject to friction or corrosive action. Iron and lead are also present usually, but in small quantities.

TABLE I.—*Composition of Various Brasses.*

	Copper.	Zinc.	Tin.	Lead.	Aluminium.	Iron.	Remarks.
Brazing metal	90.0	10.0	—	—	—	—	
Brazing metal	85.0	15	—	—	—	—	
Statuary brass	91.5	5.5	1.7	1.3	—	—	
Red Brass	85	9	3	3	—	—	
Quarter metal	80	20	—	—	—	—	
English brass	70	30	—	—	—	—	
Cartridge brass	72	28	—	—	—	—	
Admiralty alloy	70	29	1	—	—	—	
Naval brass	61.5	37	1.5	—	—	—	
Ordinary yellow	66	34	—	—	—	—	
Common yellow	50	50	—	—	—	—	
Muntz metal	60	40	—	—	—	—	
Delta metal	56.8	39	2	1	—	1.2	Trace of Phosphorus.
Manganese bronze	57	40	1	—	0.75	1	Manganese present.

Common yellow brass is only used for the less important brass castings. It is weak but suitable for light ornamental work or cheap work that is not subject to strain or shock. This mixture casts well and is readily machined. Lead and iron are usually present in small quantities, sometimes the lead being introduced by design. Muntz metal is a composition that is frequently used for general fittings, but it is a general composition used for rolled work. Delta metal is a special alloy used more particularly for brass having any special sectional shape and produced by heating the alloy and forcing it by pressure through a previously prepared die. The aperture of the die is conical, and the smaller area faces inwards in order to obtain a shearing action. This is known as the extrusion process. It is also used for castings when considerable strength is desirable. It is very tough, and has the property of resisting the corrosive influence of sea water to a very marked degree. Manganese brass, usually referred to as manganese bronze, is an alloy which is commonly used for strong castings. Its tensile strength approaches that of steel for which it is sometimes substituted when the castings required are of intricate design. This alloy offers considerable resistance to corrosion, and is used for propellers.

Bronzes.

This is the term applied to alloys consisting primarily of copper and tin to distinguish them from brass. This alloy is interesting historically, as it is considered to have been the first alloy deliberately made and used. The effect of tin in

combination with copper is to produce an alloy that is harder, stronger and more durable than copper or brass. At one time bronze was largely used for making cannon, because of its toughness, hence the term gunmetal is frequently used when referring to a bronze. The colour of bronze, though resembling that of brass, is usually lighter, but the surface becomes darker owing to oxidation. The tensile strength is fairly constant with the contents of tin up to 20 per cent., but it becomes rapidly reduced as the tin percentage is increased beyond this point. Castings that are required to withstand hydraulic or steam pressure are materially strengthened by being annealed. This not only produces a more homogeneous structure in the crystal formation, but increases both strength and ductility. As with brass, other elements are usually introduced into the bronze mixtures, thus it has been found that phosphorus, silicon, manganese and iron added in very small proportions have a remarkable effect on alloys of copper and tin, making them stronger and more malleable and increasing their corrosive resistance. Aluminium is also used, but the proportion is greater, and usually very little tin is present. Many of these compositions are more clearly defined by coupling the general term bronze with the special admixture; thus, phosphor-bronze, aluminium-bronze, and sometimes manganese-bronze, as distinct from manganese-brass.

Bronze Mixtures.

What has already been said respecting brass is applicable also to bronzes. The mixtures given in Table II may be taken as representative bronzes. In the case of bronzes, as with brasses, the majority of manufacturers and foundry foremen have special mixtures for their particular classes of work upon which they rely. These mixtures usually vary slightly from standard mixtures either with a view to effecting some economy, rendering the product more easily cast or machined, or increasing its strength.

TABLE II.—*Composition of Various Bronzes.*

	Copper.	Tin.	Zinc.	Lead.	Phos.	Aluminium.	Remarks.
Admiralty gun-metal	88.0	10.0	2.0	—	—	—	
Bell metal	80	20.0	—	—	—	—	
Commercial gun metal	84	9.0	6	1	—	—	
Phosphor bronze	88	10.5	1.0	—	0.5	—	
Bearing bronze	88	10.0	—	10	—	—	
Gear bronze	88.7	11	—	—	0.3	—	
Hard bronze	83.5	14	1.5	1	—	—	
Speculum metal	66	35	0.8	—	—	—	Arsenic present.
Coin bronze	95	4	1	—	—	—	
Aluminium bronze	83	—	—	—	—	10	7 % iron present.

The Admiralty mixture is one of many. It is probably the best known of the standard mixtures, and is used for important castings, especially those that are subjected to high steam pressure, such as valve chests, valves and seatings. It is also used for hydraulic work and many kinds of machine parts. Bell metal of the composition given is frequently used for dies, as well as for bells. It is a very hard mixture. An approximate composition of a commercial gunmetal is referred to which, besides being fairly strong, is comparatively easy to cast and machines well. This is used for more general work. Practically all bronze compositions are strengthened by the inclusion of a trace of prosphorus. It is used more especially for removing the oxide from the alloy which weakens the structure. Phosphor bronzes vary much in composition, according to the purpose for which the casting is to be used, and that given is suitable for bushes for castings that provide watertight joints and for castings that require to be of considerable strength. Bearing bronzes usually contain lead varying in percentage according to the load on the bearing and the shock to which it is likely to be subjected to. Lead reduces the strength of the alloys, but its introduction facilitates lubrication. The mixture given is suitable for bearings for high speed and medium pressure. Compositions containing considerable percentages of lead are frequently specified for bearings that are to be lined with white metal. The strength is then reduced for no purpose, and it would be cheaper, as well as providing a stronger casting, to use brass. Gear bronzes need to be tough, and phosphor-tin is frequently introduced to cleanse the alloy. A specially hard bronze is sometimes desirable for bushes and bearings. Speculum metal is an extremely hard white bronze capable of taking a very high polish, but it is difficult to cast it free from blemish.

Fluxes used in Melting.

The great difficulty with regard to the casting of copper alloys is that they have an affinity for oxygen and absorb it. In making up mixtures in virgin metal it is necessary to reduce the contact of the metal with air to a minimum. With copper it is essential to use a charcoal covering at the time of melting. This has a greater affinity for oxygen, and removes much that may have been absorbed by the copper, but in this way the charcoal only comes into contact with the surface, and does not deoxidise the whole of the metal. The oxygen is more effectively removed from copper by holding charcoal inside the metal. Other deoxidising agents are, however, effectively employed in the case of copper, such as phosphorus, manganese or silicon. These enter into the whole fluid mass and combine with the oxygen, the oxides formed rising to the surface. Zinc is an important deoxidising agent also, hence brass is not subject to oxidation to the same extent as bronze. Zinc is frequently added to bronze mixtures for the purpose of purifying the composition, because both tin and copper form oxides that do not rise to the surface. These oxides weaken the crystalline structure unless they can be made to rise to the surface as scum. Tin will reduce the oxides of copper, but the oxygen is still held in the mixture as an oxide of tin. In melting the copper-zinc alloys or the copper-zinc-tin alloys, there is a reasonable loss of the zinc caused by oxidation. This is due to the reduction of the oxides of copper or tin and the zinc oxide formed rising to the surface and also to the volatile nature of the zinc. The amount that may be lost in this way varies with the mixture used and with the melting conditions, but when making up mixtures allowance for this loss must be made either when the charge is made up or after the metal has been melted. It is a common practice to add spelter (zinc) before casting the alloy, and when stirred this not only compensates for the loss, but gives the mixture a final cleansing. Phosphorus in the form of phosphor-tin also has remarkable cleansing properties. This element imparts hardness to an alloy when it forms a part of the composition, but when the percentage used is very small it is practically all removed in reducing and removing oxides. It may be used for this purpose only, and the resultant composition contains only traces of phosphorus. Silicon has been found to give the most satisfactory results in reducing and removing the oxide from copper when this metal in a comparatively pure form is required to be cast; it is, however, only used to a limited extent for the alloys of copper. The chief value of manganese also is as a deoxidiser. Its inclusion strengthens brass, but reduces ductility and increases shrinkage. Manganese brass, for instance, shrinks nearly 3-16 in. per ft. When manganese is introduced as ferro-manganese, the iron adds to the strength considerably.

Non-metallic fluxes are also used for the purpose of cleansing these alloys, a fairly common one for brass being known as salt cake. This consists of 5 parts of chalk, 15 parts of silver sand, 5 parts of coal dust and 20 parts of bone ash. This should be thoroughly mixed and used to cover the surface of the metal, and should be stirred into the metal when molten. For very dirty brass scrap

turnings, sweepings and the like plaster of Paris provides an efficient flux. Green bottle glass finely powdered is frequently used for good quality brass. It should be placed at the bottom of the crucible. Common salt is often used with bronze, especially with a view to removing antimony or arsenic that may be present. A fusible compound is formed with these undesirable elements which is removed from the mixture.

Durability of Refractories.

A Paper on "The Durability of Refractories" was read before the Birmingham Metallurgical Society at the Birmingham Chamber of Commerce on Thursday, November 1, by MR. W. J. REES, B.Sc., F.I.C., MR. H. B. JACKS (President) in the chair.

The Paper indicated progress in several directions, especially in the improvement of the silica brick and its extending use.

The Author said that the essential importance of refractory materials in modern civilisation arose from the fact that they lay at the basis of all industrial operations. Less than a generation ago the technical study of refractories was on a low plane in this country, but in the last few years leeway had been made up, to the advantage of both manufacturer and user. That was partly due to the urgent requirements of maximum production during the war. The average quality of the silica brick was decidedly higher than formerly, and the same might be said of types of commercial refractories. At the same time still higher resisting qualities were essential in the interests of the basic industries of the country. The natural resources of raw materials for the manufacture of fireclay and silica bricks were of great extent, and at least equal to those of any other country, but there was still room for improvement in the efficient utilisation of the products available.

Comparing Cost of Refractories.

Behaviour under service conditions must always be the final and conclusive test of equality and suitability, but the selection and use of refractory materials could not be placed on an adequate and scientific basis until their desired properties, both physical and chemical, could be specified and tested in measurable quantities. Their proper testing necessitated first of all a clear understanding of the conditions which the materials would be called upon to meet. The life of a furnace or furnace lining should not be measured in days, weeks or months, or even in heats; the only sound basis was the cost of refractories per unit of saleable product. Failure might be defined in terms of a life much shorter than the average, or in terms of a much higher cost of refractories per unit of satisfactory product.

Failures Analysed.

An analysis of "failures" which had come under the author's notice enabled them to be placed in four classes:—(*a*) Unsatisfactory quality, including lack of uniformity; (*b*) faulty selection; (*c*) faulty treatment, due either to accident, carelessness or ignorance; (*d*) the absence of a factor of safety. A common example of faulty selection was the use of silica bricks exposed to perpetual alterations of temperature. Another common mistake was to use bricks of open texture exposed to the abrasive action of hot dust-laden gases. A typical example of faulty treatment was the too-rapid heating of silica-brick structures and the failure to relieve stresses due to expansion by the slackening of in-bolts, and another mistake was the juxtaposition of materials which chemically interact at high temperatures. The absence of a factor of safety was illustrated by abnormal regenerator temperatures due to the breakdown in the reversionary mechanism of regenerative furnaces and the temporary overloading. Failures under the first two classes, namely, unsatisfactory quality and faulty selection, should be completely eliminated, and those arising from faulty treatment could be eliminated to a marked extent by the education of the charge hands, or, as has sometimes been done, by the payment of a bonus to furnace operators based on the tonnage life of the refractories or melting pots.

The durability of the refractories used in furnace construction and maintenance was dependent on the following factors:—(1) The softening temperature; (2) the mechanical strength at normal and high temperatures; (3) the thermal or reversible expansion; (4) the permanent expansion or contraction; (5) the resistance to abrasion; (6) the resistance to slag attack; (7) the permeability to gases and vapours at high temperature; (8) the resistance to abrupt changes in temperature; (9) the changes in properties after prolonged heating.

Coke Ovens and Silica Bricks.

In the modern by-product coke-oven the great mechanical strength of silica bricks at high temperatures was a consideration of importance to the oven builder. The highest grade of fireclay bricks would deform under load at a temperature well below the normal softening point, whereas a highly-converted silica brick would carry load almost up to its fusion point. At high coking temperatures, therefore, the durability of modern silica bricks would exceed that of bricks made wholly or in part of fireclay. With regard to methods of testing, those proposed by the Refractories Section of the Ceramic Society were well known and widely used, but the provision of other tests giving measurable results and the amplification of existing tests was desirable.

The Author drew attention to the great importance of careful heating at the critical temperature of 575 deg. C., the neglect of which was responsible for numerous breakdowns. In open-hearth steel practice moderately-converted silica bricks had been found highly suitable, and had led to considerable economy in steel production. Many structures had collapsed through careless heating at the critical range of 240 deg., and failures had also arisen through the use of unsuitable cements, while the amount of cement used should always be cut down to the absolute minimum. During the war, salt had been introduced into blast furnaces in order to increase the output of potash, but the crystal growth which resulted had frequently led to the breakdown of refractories. Certain kinds of coal were also destructive because of the amount of salt which they contained.

The Author, replying to some points raised in the course of a short discussion, said the expansions of silica on heating were not realised some years ago, and the discovery was mainly due to the valuable work of Fenner at the General Physical Laboratory of the United States, which definitely showed the presence of the inversion in silica. They now realised that they must exercise care in the heating of any structure containing silica bricks, particularly in view of that important change at 240 deg. C., which was not usually realised by the ordinary furnace operator. The question of jointing was very important in the construction of the furnace, and the better the bricks were fitted the greater was their durability likely to be. The cement was very often the weak spot. Professor Turner had shown some years ago that the cracking of carbon monoxide was greatly facilitated by the iron oxide present. The carbon monoxide penetrated the brick and carbon penetrated into the crack. In regard to testing, it was undoubtedly better to test the whole brick rather than portions of it, because the breaking of the brick tended to weaken the general character. With regard to the escape of heat through the bricks, he had found by some experiments that only one-third of the heat used was applied to the heating of the material within the furnace. It was very doubtful whether the water-cooling arrangement so extensively used in America could be economically applied in this country. He found it possible to maintain 1,410 deg. C. temperature by special arrangements, and had maintained it for twelve hours by careful watching and the regulation of the gas supply. With an electric furnace it would be quite an easy matter. He had found very considerable advantage result from the presence of certain small proportions of iron oxide in the raw materials.

The late Dr. J. E. Stead.

The PRESIDENT expressed the regret all metallurgists would experience at the death of Dr. J. E. Stead, of Middlesbrough. He thought the members would desire to express to the members of the family their condolence in their bereavement and their sense of the loss that the cause of metallurgical science had sustained by the death of Dr. Stead. He moved that such a resolution be sent. The vote was carried by the members rising in their places.

The Manufacture of Ferro-Alloys.-II.

BY J. A. HOLDEN, M.I.BRIT.F.

FERRO-SILICON.

The range of alloys covered by the term ferro-silicon contain from 12 to 95 per cent. of silicon. For commercial purposes they may be considered to be binary alloys of silicon and iron, with carbon, sulphur and phosphorus as impurities. It is, however, not unusual to find other impurities present, particularly if the raw materials have been carelessly selected. With the exception of the low grades containing about 12 per cent. of silicon, the alloys are prepared exclusively in electric arc furnaces.

Ferro-silicon is used for a variety of purposes. The low grades are often used in foundry work; all grades up to 75 per cent. are used by the steel maker. Acid-resisting irons are made from special grades of ferro-silicon containing carbon. The high grades from 75 to 90 per cent. are extensively used in the thermit preparation of alloys, and also for the preparation of such alloys as silicon-copper. Finally, the richest alloys decompose boiling water so readily that they have been used for the preparation of hydrogen for the inflation of balloons.

Very large furnace units are used for the reduction; three-phase furnaces with 24- or 26-diameter amorphous carbon electrodes operating with 10,000

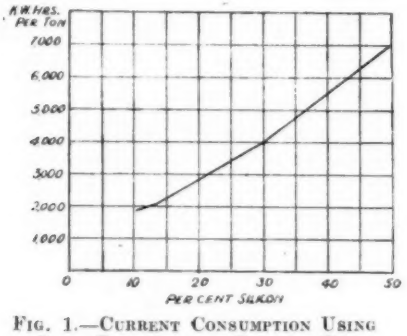

FIG. 1.—CURRENT CONSUMPTION USING STEEL TURNINGS AND GANISTER ROCK, LOW AND MEDIUM GRADES.

to 15,000 amperes per phase are not uncommon. In some works, however, small units are employed, single-phase furnaces with a bottom connection of 750-k.v.a. capacity. For economical working, the large three-phase furnaces are preferable. The furnace, which is fixed, consists of a rectangular framework of angle-iron (old rails may be substituted), embracing firebrick walls, the inner sides of which are lined with refractory ganister. In some works a furnace bottom is made by ramming in a paste made from broken electrodes, tar and pitch. If a carbon bottom is not favoured, ganister is used.

The furnaces are more often than not worked with an open top; for the low-grade manufacture this is the only practical method, because the charging is so rapid that partial roofing would be a cumbersome nuisance.

The raw materials consist of (1) source of iron, (2) silica in some form, (3) reducing agent, and (4) flux.

Iron ore may be used, but because of the large electrical consumption it is very often more economical to use steel turnings. If steel turnings are used, care must be exercised in the selection; comparative freedom from nickel and chromium is desirable, since these elements, if present, will ultimately enter the ferro-silicon. Silica can be obtained commercially of a very high degree of purity; of the three available forms, quartzite is undoubtedly the best. Usually high-grade ganister rock is cheaper; in consequence it is more frequently employed. Silica sand is more difficult to reduce, and because of its fine state of division, it is liable to choke the furnace; hence it cannot be recommended. For the latter reason, dusty quartzite or ganister rock cannot be tolerated. For a reducing agent, coke, anthracite, or charcoal can be used, and the choice is solely determined by economic considerations. Here, again, freedom from dust is desirable. The flux, lime or limestone is only used in very small quantities.

For casting, the low grades are tapped into a pig bed exactly after the manner of blast-furnace practice. For the medium and high grades, the alloy is tapped into a sand bed moulded to give a thin slab. The large furnaces are provided with two or three holes with a casting bed adjacent to each.

A new campaign is started by smelting a very low-grade alloy; gradually the iron in the charge is reduced and the quartzite or ganister rock increased; the reducing agent is altered in calculated amounts for each change. Whilst smelting the alloys low in silicon, it is not unusual to obtain accumulations of graphite. It is reasonable to assume that the iron in the charge absorbs a considerable amount of carbon before it reaches the melting zone, because there are violent discharges of carbon-monoxide (which, of course, ignite upon the cooler upper surfaces), and, as is well known, this gas exerts a powerful carburising action on the mild steel at temperatures above 900 deg. C. Later, as the silicon is reduced, the iron is thrown out of combination with the carbon—this may occur in the furnace. Usually, however, the furnace is too hot to permit of a deposition of

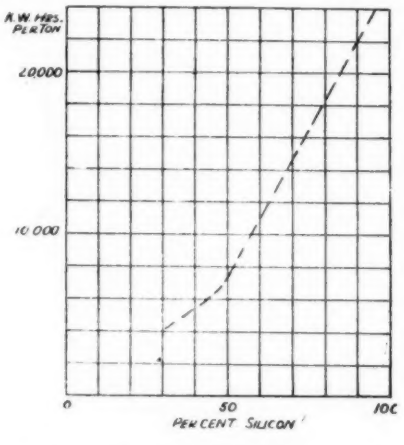

FIG. 2.—CURRENT CONSUMPTION WHEN MAKING HIGH-GRADE FERRO SILICON.

much graphite, and the reaction occurs in the pig beds during casting.

If it is desired to produce material exactly to one grade, say, for example, 45 per cent. silicon, analytical control is necessary; further, the furnace must be operated in a very consistent manner. The latter is very important, and if the tapping time comes near the change of shift hour, it will call for determination on the part of the foreman.

The current consumption on large furnaces for grades up to 50 per cent. silicon will approximate those shown by the curve in Fig. 1. On reference to Fig. 2, it will be seen that the manufacturing costs for the rich alloys are almost entirely a question of power costs.

The line voltage is usually higher for the lower grades; 12 per cent. ferro-silicon, for example, would be smelted with a voltage of 100 to 110; for the 45 to 50 per cent. alloy it would, however, be more satisfactory to work with a voltage between phases of 80. It is desirable to have two tappings on the furnace transformers, so that at a commencement of a run the higher voltage could be employed, and when the furnace is seasoned, and it is desired to make a richer alloy, the lower tappings could then be put into use.

Unlike ferro-chrome, the crushing of ferro-silicon presents no difficulty. In fact, the richer alloys spontaneously disintegrate, and if they are to be used in lump form, it is inadvisable to hold them in stock. For shipment and transport over long distances, those alloys containing from 40 to 60 per cent. ferro-silicon are to be preferred. There are, of course, the well-known regulations which must be complied with.

Grey Cast Iron from the Point of View of the Electric Furnace.*

By G. K. Elliott, The Lunkenheimer Company, Cincinnati, Ohio.

Although widely discussed, the use of the electric furnace for grey cast iron still is so limited that there is much misunderstanding and ignorance concerning the relations that exist between the elements in cast iron and the operations that are conducted in the acid and the basic electric furnaces. A correct understanding of the chemistry of both the acid and the basic-hearth electric furnaces should lie at the foundation of every decision for or against the adoption of the electric furnace in competition with the cupola. This understanding, of course, is indispensable in making a choice between the two kinds of electric furnace.

It is the writer's purpose in the present Paper first to outline very briefly the main features of the acid and the basic electric furnaces, then to sketch the effects of each upon the principal elements of cast iron in comparison with the effects obtained through the cupola, and finally to touch upon a problem or two of cast iron that have arisen through the introduction of the electric furnace for treating cast iron.

Acid and Basic Linings.

The acid electric furnace is lined throughout with materials that are acid in their chemical properties and reactions. Especially is the hearth or bottom made of acid material which always is some form of silica. By a chemist silica would be described as de-hydrated silicic acid. Ganister is the form of silica most widely used for acid hearths. The side-wall from the slag line up and the roof are made of silica brick. Using acid material in the hearth makes possible the employment of highly siliceous or acid slags on the surface of the metal. These are hardly as active as basic slags, but they serve the excellent purpose of protecting the metal from the furnace atmosphere and of assisting in a certain amount of refining. Acid furnaces are simpler to operate than basic ones; also acid refractories are cheaper than basic ones.

The basic electric furnace has its hearth built up of sintered magnesite†, chemically a base. Above the slag line it is lined entirely with silica brick in a manner similar to the acid furnace. Therefore the sole difference between the acid and the basic electric furnace is in the material making up the hearth. The magnesite† bottom of the basic furnace makes it possible to work the metal under a lime slag which also is basic and accordingly not incompatible with the hearth material. A lime slag would attack quickly an acid bottom just as an acid slag would quickly ruin a basic bottom.

In the preceding paragraphs no attempt has been made to do more than outline in simplest form the two kinds of electric furnace hearths. In the following there will be introduced points of difference in their behaviour towards molten cast iron.

Regulation of Carbon.

Aside from the iron itself, carbon is the most important element in cast iron, and it is its presence in large quantity in the uncombined or graphitic form that distinguishes cast iron from steel. Its quantity and condition determine the hardness, the strength and many of the other mechanical properties of iron. Therefore it is most important to know exactly what effect the various furnaces we are considering have upon this all-important element. In the cupola, the iron is at all times in intimate contact with carbon in the form of coke, and the tendency is very strong for the iron to approach the saturation point in dissolving carbon. Thus the writer has seen charges containing from 50 to 100 per cent. going into the cupola with a gross carbon content of from 0.2 to 1.80 per cent. (depending upon the percentage of steel in the charge), and coming out at the spout with 2.50 to 3.00 per cent. total carbon. The natural tendency of the cupola is to saturate as nearly as possible the iron with carbon. The only regulation of carbon that can be attempted in the cupola is by dilution with steel additions as is often practised in the manufacture of so-called semi-steel. Even here the influence of the cupola is toward wiping out the theoretical effects of this dilution. It is a difficult task effectively and accurately to regulate the carbon of iron in a furnace in which the molten iron constantly is in intimate contact with incandescent carbon.

In the electric furnace, acid or basic, carbon regulation is ready and accurate. Carbon reduction is obtained with almost mathematical precision by diluting with steel because the adverse features noted in the cupola are entirely lacking. In fact, the mixing of cast iron and steel in the electric furnace produces the truest semi-steel that is known; it lacks the freakish uncertainty of the usual cupola product. Another method for carbon reduction that is made possible by the electric furnace, but one that is practised very rarely, is to oxidise it out of the iron by means of some form of iron oxide thrown upon the bath in emulation of the common practice of the steel-maker.

By additions of powdered coke of good density, carbon may be built up in the electric furnace. Up to about 3.20 per cent. this is accomplished fairly readily, but from there up, although possible and frequently done, the process is fraught with danger of long drawn out heats or failure. When total carbon of 3.50 per cent. or higher is desired it is most economical not to rely upon the furnace for an excessive amount of carburisation. The subject of carburisation is one of the most important connected with the electric furnace metallurgy of cast iron and is in need of further study and wider dissemination of existing reliable information.

Importance of Silicon Control.

Next to carbon the most prominent element in cast iron is silicon. It is the chief intermediary through which the foundryman reaches the carbon and bends it to his will. It does much to control the condition of the carbon, determining whether it be combined as carbide or uncombined as graphite. In the cupola a certain amount of silicon always is lost by oxidation, although in a well-managed cupola it is capable of very satisfactory regulation by making the original silicon of the charge high enough to take care of the anticipated loss. In the basic electric furnace there generally is a loss of 0.10 to 0.20 per cent., although not always necessarily a loss, depending upon several factors. In the acid furnace there is no loss and, under favourable conditions, there can be a very material pick up of silicon reduced from the siliceous slag. In either kind of furnace, silicon is increased most easily by additions of ferro-silicon. Raw materials always should be chosen so that it never is necessary to reduce silicon in the electric furnace because the deliberate throwing away of silicon is economically wasteful, although it can be done either by dilution with material low in silicon or by oxidation.

Manganese.

Manganese has at least a two-fold importance in cast iron. In the first place it takes care of the sulphur, holding it as manganese sulphide instead of the more harmful iron sulphide. In the second place the manganese not thus engaged forms carbide and thereby has a very perceptible effect upon the hardness and other mechanical properties of iron. In the cupola, manganese suffers a loss generally running from 0.10 to 0.20 per cent. As with silicon, this is the result of oxidation. In the acid electric furnace the loss of manganese may reach 0.40 to 0.50 per cent., which has to be made up by additions of ferro-

* A Paper presented to the Cleveland Congress of the American Foundrymen's Association.

† Dolomite is usually used in Europe.—Ed.

manganese late in the heat. The basic furnace, on the other hand, is rigidly saving of manganese, the loss being *nil*, except under an oxidising slag such as never is used for cast iron. Low-manganese iron can be taken from the basic electric furnace only when the original charge is low in manganese. Another point concerning this element is that electric-furnace cast iron does not seem to require as much manganese as does the cupola product in order to produce a given quality of iron.

Phosphorus.

Phosphorus is a more vital element in cast iron than many persons suppose. It has much to do with fluidity, and one feels like declaring that it has done nearly as much to popularise grey cast iron as has any other factor, accomplishing this by reducing certain hazards which are apparent whenever low-phosphorus iron is being handled in the foundry. What would the great majority of iron foundries do if deprived of all medium and high-phosphorus pig irons? In the cupola phosphorus undergoes no change, and whatever goes in comes out—sometimes plus a small amount that was in the coke. In the acid electric furnace there is no effect possible upon phosphorus. In the basic furnace, theoretically it is possible to reduce phosphorus, and it is done commonly in steel practice, but for cast iron it is thoroughly impracticable. It could be eliminated only through oxidising basic slags; but before being within reach of the reaction practically all the carbon, silicon and manganese would have to be removed by oxidation. In other words, the iron first would have to be reduced to steel, then after dephosphorising the carbon, silicon and manganese would have to be put back in the iron—the steel remade into grey iron.

Nevertheless, the electric furnace has an important relation to phosphorus in cast iron in that, through its infinite power of superheating, it makes possible great fluidity in iron low in phosphorus. There is no doubt that phosphorus subtracts from the physical endurance of castings, especially those that are subjected to shock, vibration and other dynamically applied stresses. Because of its weakness as a superheater the cupola is not always able to deliver low-phosphorus irons with the needed fluidity. Considering for the moment the duplexing process, an electric furnace will in considerably less than an hour superheat to a degree of fluidity that is ample for any purpose, the sluggish melt from a cupola struggling with low-phosphorus iron.

Sulphur.

Sulphur usually is viewed with the greatest charity because it is somewhat of a necessary evil in cast iron. In the cupola there always is a very pronounced increase in sulphur extending from 0.02 per cent. where the best grade of coke is used to over 0.05 per cent. for the poorer grades. As cast iron is remelted over and over its sulphur becomes progressively higher and higher. In the acid electric furnace there is no change wrought in the original sulphur, except in the case of high sulphur (about 0.150 per cent.) and high manganese when by a kind of flotation the manganese sulphide may rise to the surface of the bath by reason of the lowered viscosity of the metal at the high temperature.

In the basic furnace there occurs with sulphur one of the most valuable reactions connected with the electric furnace metallurgy of cast iron. Due to the calcareous slag and the deoxidising conditions brought about by the use of powdered coke on the slag, sulphur is effectively reduced by a series of chemical reactions which may be summarised in the following simple reaction:

$$MnS + CaO + C = Mn + CaS + CO$$

Often calcium carbide which can be made only at electric furnace temperatures is formed and aids powerfully in desulphurisation. The following shows how desulphurisation proceeded in one heat of duplexed iron in which the reduction was pushed to an unusual limit:

From the cupola	...	0.156 per cent. S.
10 min. in E. F.	...	0.133 ,, ,,
20 min. in E. F.	...	0.112 ,, ,,
30 min. in E. F.	...	0.079 ,, ,,
40 min. in E. F.	...	0.036 ,, ,,
50 min. in E. F.	...	0.031 ,, ,,
64 min. in E. F.	...	0.014 ,, ,,

One of the problems for which the electric furnace is responsible concerns the true effect of sulphur upon the mechanical properties of grey cast iron. The basic furnace has made easily accessible lower sulphur castings than previously were ever thought possible. As a result there has arisen some question as to the value of extremely low sulphur in grey iron and as to how high sulphur can go without working harm. There is a marked lack of convincing information and a great mass of contradictory evidence about the influence on iron of those non-metallic inclusions, the sulphides. The writer desires to make no brief for excessively low sulphur, nor does he deny that excellent castings are made with irons fairly high in sulphur, but his strongest conviction is that castings low in sulphur are worthy of the greater confidence because one can rest assured that they were made either from good pig-iron and scrap, expertly melted and cast under favourable conditions, or else from iron that has passed through a drastic deoxidation and refining—as in the basic electric furnace—that has reduced not only sulphur, but also oxides and perhaps other impurities more harmful than sulphur itself. The presence of sulphur in quantity need not unconditionally condemn an iron, but certainly its absence is a strong recommendation. Low sulphur in a casting cannot be considered otherwise than a stamp of quality.

Tests Needed to Show Effect of P and S.

In considering the sulphur problem we are brought face to face with another problem of cast iron which concerns methods of mechanical testing. To the writer it seems that the present standard tests for grey iron are sadly lacking in scope and variety when put to the task of detecting the more latent virtues of different varieties of iron. The most of the tests of iron are transverse, with tensile tests made to a lesser extent; hardness tests also are made in a few plants, which about completes the list.

Transverse and tensile tests both are decidedly static in nature, and, because of the peculiar structure of cast iron, are admirably fitted to give the most flattering estimates of its mechanical properties. The writer hopes to see the introduction of tests of a more dynamic nature because he believes they may reveal shades of difference in cast irons to which the customary tests are not sensitive. The available literature, for example, contains so little concerning the resistance of cast iron to impact that we urge a freer distribution of existing data, if there be any, and a more systematic gathering of fresh data by testing many varieties of cast iron. In urging this we are in full knowledge that cast iron is at its worst under these conditions, but it is felt that more rigorous tests may disclose differences to which the usual tests are entirely blind. Perhaps they may make manifest some of the elusive effects of varying proportions of phosphorus and sulphur. Dynamic tests may help clear up the sulphur problem. In this connection the writer is glad to record that a committee on impact testing has been organised very recently by the American Society for Testing Materials and that one member has been chosen especially to represent cast iron upon this committee.

Indian Stores.—While fulfilling the ordinary functions of a railway-stores department, the main depôt of the North-Western State Railway at Moghalpura handles a wide variety of work, while the associated depôt at Karachi distributes supplies for the district arriving from overseas for other Government departments, as well as for the railway. A ruling principle of the Stores Department is to give preference to Indian-produced raw materials and Indian manufactures therefrom, or to articles manufactured from imported materials for which a substantial part of the manufacture has been conducted in India. In both cases, however, quality must be equal to and cost as low as in the case of corresponding articles obtained through the India Office. Special purchases in India of English-manufactured articles are made when serious inconvenience would be caused by waiting to obtain an article from England, or when, owing to the greater promptitude of supply, an economy can be effected by purchasing in India.

The Strength of Cast Iron (Semi-Steel Mixtures) at High Temperatures.

By Arthur Marks, F.I.C., Works Metallurgist, Messrs. A. Harper, Sons & Bean, Limited.

The advent of the Diesel and other types of internal-combustion engines has given rise to a demand for cast iron of superior quality to function under the exceptional conditions, such as were never present in the older types of steam engine, and rarely, if ever, present in a super-heated steam turbine. The increased power per unit volume of combustion space which is daily being demanded calls for a stricter examination of the materials available to meet the more strenuous conditions. The tendency to make use of the two-stroke cycle and double-acting engines means an increased heat load on the metal.

Commercial and foundry conditions make cast iron the most desirable material for construction of heat engines. Steel, whilst possessing greater strength, has still a long foundry youth to pass through before it may be considered to have reached the adolescent stage in the complex castings required for the motor industry, and further its poor wearing qualities do not help it as a material for castings subject to frictional wear.

With a view to investigating the cause of failure at high temperatures and the upper limiting temperature at which cast iron may be safely used, the following research has been carried out among a number of researches concerning the properties of cast iron.

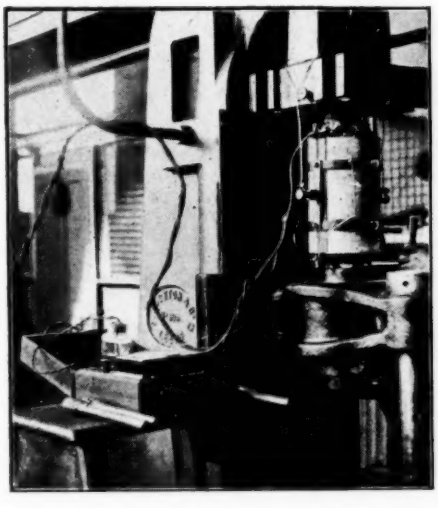

FIG. 1.—APPARATUS USED FOR THE DETERMINATION OF THE TENSILE STRENGTH OF CAST IRON AT HIGH TEMPERATURES.

The first object in view was to determine the temperature at which cast-iron mixtures, when heated, showed a rapid drop in strength. The samples of material were cast from one ladle into dry-sand moulds, placed vertically for casting and allowed to cool completely before knocking out of the box.

They were then machined parallel for some 16 in. and given a standard taper and curvature at the shoulders. The heating was accomplished by means of an electrically heated furnace, just capable of heating the whole length of the test bar suspended between the jaws of a tensile machine. The temperatures were taken by means of a thermocouple firmly bound against the test piece in the centre of the furnace. Ingress of air to the furnace was prevented by plugging with asbestos fibre. The plant used is illustrated in Fig. 1.

Some 8 bars were broken, each bar being heated up to a specified temperature, the temperature being allowed to remain constant for ten minutes. The load was then applied and the breaking load taken. The bars were allowed to cool and the elongation measured. The results are shown in Table I.

TABLE I.—*Temperature—Strength Data. (Curve A in Fig. 2), obtained from Heating Cast Iron (20 per cent. Semi-Steel), for 10 minutes at a constant temperature before breaking.*

No.	Diam.	Temperature.	Tons.	Extension on 14.	Per cent. elongation.
1	0.798	Ordinary	15.6	0.03	0.21
2	—	125.0	15.5	0.03	0.21
3	—	200.0	15.4	0.03	0.21
4	—	310.0	15.0	0.035	0.24
5	—	400.0	14.5	0.035	0.24
6	—	520.0	13.8	0.04	0.28
7	—	575.0	13.1	0.04	0.28
8	—	620.0	10.4	0.04	0.28
9	—	650.0	10.3	0.04	0.28
10	—	675.0	8.4	0.04	0.28

The results show that with this particular composition of cast iron the safe range is up to 550 deg. Cent., at which a strength of 13.5 tons was obtained. The piston and cylinder heads of an engine do not attain this temperature when properly water-cooled.

The failures of the strongly-heated test pieces may be due to either of two causes: (1) Natural reduction of cohesion with temperature rise; or (2) chemical change in the metal bringing about

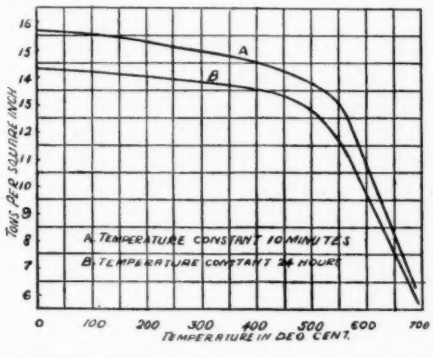

FIG. 2.—TEMPERATURE STRENGTH CURVE OF CAST IRON (20 PER CENT. SEMI-STEEL).

the formation of graphite and so reducing the strength.

To determine which is the predominant cause a new series was, therefore, put in hand, and the operation repeated, but in this case each test piece was heated for 24 hours and analysis of the material made. One bar was also heated for 36 hours. Table II gives the figures obtained from this test. The curve for the second test is shown below the first curve, from which it will be noticed that it follows a practically parallel course (Fig. 2), the safe limit being at 550 deg. Cent.

TABLE II.—*Temperature—Strength Data. (Curve B, Fig. 2), obtained from heating Cast Iron (20 per cent. Semi-Steel), for 24 hours at a constant temperature before breaking.*

No.	Temperature.	Tons.
1	Normal.	14.4
2	100.0	14.2
3	210.0	14.0
4	295.0	12.9
		Flaw at fracture.
5	410.0	13.6
6	505.0	13.1
7	600.0	8.9
8	700.0	6.8

Very careful analysis proves that in each case the combined carbon at the centre of the bar where

the fracture took place showed no change. The breakage was, therefore, to be regarded as not associated with change of composition, *i.e.*, the production of weak graphite by decomposition of iron carbides, but as the natural reduction of cohesion at high temperature.

TABLE III.—*Analysis of Test Pieces.*

Before heating.		After heating 24 hours.		
		Bar No.	Gr.	C.C.
	Per Cent.		Per Cent.	Per Cent.
T.C.	3.5	1	2.87	0.65
Gr.	2.87	2	2.85	0.65
C.C.	0.65	3	2.86	0.65
Si.	1.2	4	2.87	0.65
S.	0.075	5	2.84	0.65
P.	0.31	6	2.86	0.65
Mn.	1.10	7	2.85	0.65
		8	2.86	0.65

The fact that cast iron shows no chemical change after losing its strength indicates that this is not so much a problem for metallurgical research as a case for the engineers to restrict the temperature to which it is subjected below the quite reasonable one of 550 deg. Cent.

The Motor Ship recently lamented the lack of high standard in the metallurgy of cast iron, but this material is surely being expected to stand up to unreasonable conditions. It is quite common experience to find the water-cooled portions of motor engines filled with solid chunks of non-conducting deposits from the cooling water due to inadequate speed of flow. These deposits prevent the cooling of the iron to a safe temperature and failure occurs. It is quite possible in the foundry to-day to make cast irons which will stand repeated heatings to 550 deg. Cent. daily for years without showing signs of cracking or "growth." Engine parts from these materials can be cast and made to withstand the heat while having two to five inches of scale from the cooling water deposited on them over a period varying from two to ten years!

Cracking of castings on the test bed can be eliminated by correct foundry practice, as the best cast irons can be rendered defective by legitimate but none the less unsatisfactory foundry practice.

Great improvement in the life of castings of heat engines is to-day possible by the application of existing knowledge of cast iron and foundry practice. Further, knowing the limiting temperature above which cast iron will break off, it is essential to keep below this temperature by satisfactory water-cooling, and to avoid using an engine as a crystallising plant. No metallurgical research will eliminate the latter trouble.

Contracts Open.

Dungannon, November 22.—360 yards 5-in. turned, bored and coated cast-iron pipes, for the Dungannon Rural District Council. Mr. W. M'Guffin, clerk, Dungannon.

Grangemouth, November 30.—820 tons (Contract No. 2), or alternatively, 1,411 tons of 12-in. diameter cast-iron pipes and specials (Contract No. 3), for the Town Council. Mr. D. A. Donald, C.E., water engineer, Town Hall, Grangemouth.

Johannesburg, January 3.—Cast-iron meter boxes, for the Municipal Council of Johannesburg. The Department of Overseas Trade.

London, S.W., November 20.—(1) 150 covered goods wagons, four-wheeled, I.R.C.A. standard type A2; (2) 107 tons spring steel; and (3) brass wire and tubing, copper ingots, rods, tubes, sheets, etc., antimony, etc., for the Madras and Southern Mahratta Railway Company, Limited, 25, Buckingham Palace Road, Westminster, S.W.1. (Fee, £1 1s., non-returnable.)

Plymouth, November 16.—2,600 yards 36-in., 1,120 yards 26-in., and 1,000 yards 21-in. cast-iron pipes and special castings, for the Plymouth Corporation Waterworks. Mr. F. Howarth, water engineer.

Southborough, November 19.—Provision and laying of about 1,550 yards of 6-in. cast-iron water main, for the Southborough Urban District Council. Mr. W. N. Wood, clerk, Council Offices, Southborough.

Torquay, November 15.—2,160 tons of 14-in., 12-in. and 7-in. diameter cast-iron pipes and special castings, for the Town Council. Mr. S. C. Chapman, waterworks engineer, Municipal Offices, Torquay. (Fee, £2 2s., returnable.)

Rubber-Tipped Rammers.

By J. McLACHLAN.

It is surprising that so few foundries have adopted rubber-tipped rammers. They are not exactly a new thing, but probably it is conservatism rather than prejudice that prevents their more general adoption for light work especially. The rubber tip is, of course, a ferrule that fits on the end of the rammer. The writer was in a foundry recently where they have been in general use for small work for some years, and the foundry manager was high in praise of them.

Ramming is so much the everyday work of the moulder, and he becomes so proficient in it that the proper degree of hardness is attained almost without conscious effort. Yet it is a part of the foundryman's art which calls for high skill. Careless ramming inevitably results in waster castings.

The advantages of rubber-tipped rammers are that the mould is usually better rammed, that there is less possibility of scabs, and the pattern, if fragile, is not as likely to be damaged if inadvertently struck by the rammer. The rubber is more resilient than iron or wood, therefore, it is less likely to fatigue the moulder and also because of this resiliency there is probably less likelihood of the mould being rammed in clearly-defined layers although this is open to question. The ideally-rammed mould is admittedly one which is not a series of sand thicknesses, but one solid body of sand uniformly rammed throughout.

With regard to the saving of the pattern, it is easy to exaggerate this, but patterns are sometimes damaged when ramming the mould. This happens sometimes even when the moulder has tucked the sand carefully round the pattern with his fingers before using the rammer. With a block pattern, stoutly made, a knock from a rammer will not do it much injury, but it is somewhat different with a shell pattern. It is nearly always because of the patterns that rubber-tipped rammers are used. But there is an even more important reason for their adoption. Many moulders do not know how easily scabs are caused by the rammer touching the pattern. What actually happens is that a film of sand is formed next to the pattern. When the sand is rammed against this the grains do not interlock properly and there is thus a joint formed. This may not be observed when the pattern has been drawn and the face of the mould will appear quite sound. When the metal is poured, however, the thin film of sand may be washed off, thus causing a scab.

Rubber-tipped rammers are naturally more costly, but if they result in better work they are a good investment. Not all moulders speak well of them, but a good deal more can be said in their favour than against them.

THE SUGGESTION to form an Engineers' Club in Birmingham has again been revived.

DR. IRVING, of Liverpool, delivered an interesting lecture on "The Scientific Treatment of Boiler Feed Water and Water Purification" to the members of the Stoke-on-Trent Engineers' Association last week.

MESSRS. P. K. BLUNT AND G. O. C. TABBERER, trading under the style of the Vaughan Engineering Company, 73, Vaughan Street, Leicester, have dissolved partnership. Mr. P. K. Blunt will continue the business.

APPLICATIONS HAVE BEEN INVITED for an issue of £1,000,000 4½ per cent. guaranteed "A" mortgage debenture stock, 1929-48, in the Tata Power Company, Limited, guaranteed as to principal and interest by H.M. Government under the provisions of the Trade Facilities Acts, 1921 and 1922. The price of issue is £97 per cent. The company was incorporated in 1919 and is the largest of three power supply companies formed under the concessions acquired by the Tata company from the Government of Bombay. The proceeds of the present issue will be devoted mainly to the purchase in Great Britain of machinery and plant required.

Institute of British Foundrymen.

LANCASHIRE BRANCH.

At the first meeting of the Session, over which Mr R. Miles presided, Mr. Paul, of the Stanton Ironworks Company, read a Paper on "Iron and Its Production." After a few historical notes, the lecturer described the production of pig at the Stanton Works, starting with the composition of the ores used and their calcination. A description of the blast furnace plant was followed by some notes of the composition and quarrying of the limestone. The Stanton plant quarries are at South Witham and Wirksworth. It contains 92 per cent. $CaCO_3$, and is contaminated with 2.6 per cent SiO_2. An interesting section of the Paper was that which first illustrated typical fractures of the various numbers and the micro-structures which were to be associated with them. When dealing with the waste gases from the blast furnace, Mr. Paul stated that for each ton of pig-iron made no less than 10½ tons or 315,000 cub. ft. of gas were produced. The disposal and use of slag for road metal was dealt with and a description of a plant capable of producing 250 tons of tarred slag per day of 16 hours was given. It is interesting to note that 7 gallons of tar are required for 1 ton of slag.

When dealing with the extraction of by-products from blast furnaces using coal as fuel, it was stated that for every ton of coal used 25 lbs. of sulphate of ammonia, 120 lbs. of pitch and 10 gallons of creosote oil were recovered.

Discussion.

MR. H. SHERBURN said a serious subject was the question of grading irons. Makers were very keen on keeping to fracture as the basis for selling, and apparently Mr. Paul had adopted it in his classification of pig-irons. It also appeared that at times the furnaces did not work well and produced a certain amount of faulty material which did not reach very large consumers who insisted upon the iron they bought being up to a certain standard measured by chemical analysis. Then what happened to it? It presumably went to the small founders, many of whom were represented in the meeting. They received material which the big firms refused. It would be very gratifying to have an assurance from Mr. Paul that makers were taking steps to guard the interests of the small consumers as well as of the large ones. The members knew how great were the difficulties of a foundry foreman or manager who had no chemical laboratory at hand and was called upon to deal with material which was not found to be faulty until it had done further mischief by spoiling moulds. The small consumer's interest should be considered.

MR. PAUL said if he had to buy pig-iron he should do it on analysis and not by fracture. Let the buyer state what he wanted in the way of silicon, sulphur content and so forth; then if he was promised material according to that description and he did not get it the remedy was in his own hands. If the small consumer was not receiving due consideration at the present time that state of things would soon be changed for the better; the small consumer would have to be supplied with the material which he paid for. It was quite as essential to him and as much his right as it was in the case of the large consumer. If he could rely upon getting an iron with, say, 3½ per cent. silicon when he ordered it he knew what scrap he must mix with it. Buying by analysis should enable him to secure that 3½ per cent., but when buying by fracture it was a different matter altogether. He had shown an illustration of a No. 1 iron with 3½ per cent. silicon; it would be possible to get a No. 1 iron with a similar fracture in which the proportion of silicon might be only 2 per cent. When that type of event happened the foundryman was bound to be let down, however skilful he might be in his work.

MR. S. G. SMITH said the subject was a very interesting one, and opened up great possibilities of discussion. His own advice was to buy by analysis. The best foundryman might be deceived if he relied upon fracture alone. But it was a difficulty that there were not many firms who guaranteed that they would sell metal by analysis. He had been closely associated with blast furnaces for 35 years, and knew something of what went on, and thought there should be some relation between fracture and analysis.

From what the lecturer had told them about by-products it would almost appear that the prosperity of the pig-iron maker was based upon them. Was any use made of the slag produced by the furnace?

MR. PAUL: Yes, for road making.

MR. SMITH: Some reference was made to the use of slag with cement.

MR. PAUL said in the concrete pipes nothing connected with the blast furnace was used. Slag could not be usefully employed in making centrifugal concrete pipes because it contained a high proportion of sulphur and was also porous when of small size, say ¼ in. The centrifugal action brought the porous slag into the inside of the pipe and caused a roughness which they could not afford to have upon an article produced for the market. They had tried slag for that purpose, but had to discard it. The pipes were made from the best Portland cement.

Slag Heaps and the Price of Pig-iron.

Replying to further questions, MR. PAUL explained that when taking off sulphate of ammonia and the different oils, if dusty ores were used the dust was liable to be carried along, and it raised the ash in the pitch. Several firms had adopted a screening arrangement, the fine ores being separated and made into briquettes. In some places the fine ores were made into nodules about the size of a man's fist. From his experience he should say it paid to extract the small ores and make them into briquettes. The iron was more regular, the gas was kept free from dust, the pitch was cleaner and better, and the furnace was worked more economically. The blast passed through the body of the ore more easily.

MR. J. HAIGH asked what would be likely to happen to the price of iron when all the slag heaps had been used up, if, as Mr. Paul said, the pig-iron trade was at present existing on its by-products and not on pig-iron.

With regard to buying by analysis, when they had reached that point the matter was by no means at an end. Different furnaces might produce iron similar in chemical composition as shown by analysis, yet the results obtained might vary. There appeared to be in the various pig-irons inherent qualities which could not be got rid of, nor could they be reproduced in another pig-iron. Foundrymen would probably be in a better position if they sold their castings by analysis, but at present they had to comply with certain tests of strength, and so forth. The foundryman might specify 2 per cent. silicon and get the metal he asked for and produce the castings he wanted, but it did not follow that at another time, using iron with 2 per cent. silicon, he would get a product of the same quality. Therefore, whilst analysis was useful, it was not the last word; several other matters, such as casting temperature and cupola practice, entered into the question, and a considerable amount of practical experience was also needed.

MR. PAUL said with the big furnaces now operating at Stanton they were dealing with about 4,000 tons of slag per week, and he thought in a couple of years the slag heaps would be practically exhausted. As they were so largely dependent upon that source, it would raise a serious problem for the foundryman and the blast-furnace people. At all events, he could not hold out any hopes that foundrymen would be able to get cheaper iron. At Stanton they were differently placed from others, because 90 per cent. of the pig-iron made was used in the production of their own pipes, and they made iron that suited their own purposes. It should be quite possible for others to get the particular quality of iron that they wanted

The Buying of Pig-iron.

MR. J. S. GLEN PRIMROSE said if a foundryman specified a certain thing in pig-iron, and was promised it, he certainly ought to make check analysis to ensure that he received it. It was an interesting feature of the Paper that it showed how the waste products or one generation became the raw material of the next. The Paper was a very informative one, and of special interest to those of their number who had been able to visit Stanton Works in April.

MR. H. SHERBURN said in the past pig-iron makers had argued for fracture as the basis of selling pig-iron, and, taking it as a general proposition, it was difficult to get them to sell to analysis. But they ought to be in the same position as the foundryman who had to produce castings to comply with certain standards fixed for him; the pig-iron producer must also be prepared to satisfy certain tests, and not be allowed to send out on the market material which was known to be faulty and which ought to be passed through the furnace again.

MR. PAUL said that at one place during six months they made 21,000 tons of pig-iron with a guaranteed silicon content of 4 per cent. It was a No. 4 iron fracture. At Stanton they were making iron for the sand-cast pipes and the centrifugal pipes, and the instructions were simply to make so many tons with certain silicon and certain sulphur, the usual phosphorus and manganese contents. They could make iron to any analysis. But it did not follow that if a customer came along and wanted six tons of iron of a certain analysis he would get it. The foundryman was required to supply castings to comply with certain requirements; in his turn he should specify what he required, then it was up to the blast-furnace people to see that he received as nearly as possible the iron he ordered. Sometimes when iron was said to be unsuitable the maker accepted a lower price rather than take it back. That might be carried too far. A man might say to himself, "I will complain about this, get a reduced price, and then keep it for a job that it suits."

COVENTRY BRANCH.

Discussion on Mr. Dicken's Paper on "Fine Limits in Foundry Practice."

MR. PLAYER remarked that Mr. Dicken had touched very widely on foundry practice as carried on in Coventry. He had found the human element very complex. Large percentages of machine shop wasters were very often due to their waiting until after large deliveries had been made before anything was done with the castings. Foundries often received urgent notes from the machine shops intimating that they were so many behind on schedule, and that the machines were held up, and then the foundry worked too quickly and created more scrap. He was afraid that Institute meetings there had little influence on the powerful men in the designing office, the jig and tool shops and the machine shops. If by any fortuitous chance any remarks of his could reach those people what he would like to emphasise most strongly was that there was no greater handicap placed on the foundry in repetition work than the policy on the part of the machine shop of not letting the foundryman have very early information relative to the castings.

MR. BROUGHALL remarking that hitherto it had been the custom not to discuss the Presidential address, humorously observed that this occasion gave the President an opportunity to say anything he felt disposed without fear of being criticised.

As Mr. Dicken had intimated that he preferred discussion, MR. BROUGHALL said that he thought a better title for the Paper would have been "Defective Castings and How to Palm Them Off on Another Department." They would probably have noticed that whenever Mr. Dicken described some fault in a casting it was either put down to the designer, the pattern shop, the machine shop, or the jig and tool draughtsman, but it was apparently very rarely the foundryman's fault.

MR. DICKEN: I beg pardon. I showed several castings on the screen illustrating defects concerning the machine shop, pattern shop, jig and tool design, and also faults connected with the foundry.

MR. BROUGHALL, continuing, said that as one who had to supervise both machine shops and foundries, he felt a strong sympathy for both departments. If there would be encouraged a real spirit of co-operation between the various departments, much wastage could be avoided, and he was confident that if they could secure such a desirable thing as a co-operation between the drawing office, pattern shop, machine shop and foundry, the results would be surprising. In fact, no foundry could run smoothly unless this arrangement existed.

As regards accurate castings, they know that the whole secret of obtaining these lay with the class of pattern and core-box from which they had to work. If moulders and core-makers were supplied with good patterns and good core-boxes there should be no difficulty in working within fine limits.

He was rather sorry that Mr. Dicken had touched on cupola practice in the way he had, because he disagreed with much that Mr. Dicken had said. However, perhaps Mr. Dicken would give a paper on this subject at a later period when the matter could be fully discussed.

In conclusion, MR. BROUGHALL congratulated the President on his address, acknowledging that Mr. Dicken had given a lot of thought to his Paper.

Importance of Gauges.

MR. MORGAN WILLIAMS observed that he had of late come across several of the difficulties mentioned by Mr. Dicken which could be traced to the source in accordance with what had been said. It was found that the machine shop was partly responsible, and he had come to a conclusion which entirely supported Mr. Broughall's advocacy of co-operation between the machine shop and the foundry. Going through a mass-production machine shop recently he realised how important it was from the machine-shop view that castings should be as regular in dimensions as possible, because a shop with large quantities being machined in rotation must, to be economical and profitable in production, avoid every source of loss of time. If there were any dimensional defects in castings they straight away increased their overhead charges. Machinists undoubtedly had their difficulties, and foundrymen should do all they could to help them. He had in mind a particular casting for a crank-case of a pleasure car. For the first machining operations, of the four locating points three were formed by cores, and the previous day four castings came back out of a large number delivered which rocked on the supporting pins. There was nothing very much wrong with the casting, but they happened to know from previous trouble how these castings were jigged, and what they arranged for the cores to be set in the moulds by means of gauges. He might say that the intelligent use of gauges had helped them a great deal in difficulties of that nature. Another case he mentioned was also a four-cylinder crank-case, this time for a commercial vehicle. It was a particularly difficult casting to make, as the cores were very heavy to handle, and it was as much as the assembler could do to lift one of the main body cores and place it into its print in the mould. However, the machinist jigged these castings from the core joints on the inside; and he pointed out that in order to get such long castings machined correctly it was of the utmost importance for the cores to be accurately placed. The only way of overcoming the difficulty appeared to be first to check the cores with suitable gauges before insertion into the moulds, and then to check the position of the cores in the assembled mould with further gauges and templates. This arrangement enabled that casting to be machined correctly and provided for due contraction, and in that way they had really been able to overcome many of the difficulties which seemed to be inherent in foundry work. Obviously the machine shops must have accurate castings to work upon, and therefore it was for the foundrymen to use every ingenuity to supply them.

MR. JUDD observed that there was one limit which Mr. Dicken had not touched upon in connection with mass production. They required

sound castings which could be machined as easily as possible. In this respect the foundry was up against a difficult problem, especially in Coventry, where it was necessary to get very sound bores in cylinders of various descriptions. It was not an easy matter to do this with soft iron, and it would be a good thing if that could be driven home to some of the superintendents of machine shops. In reference to the mixture to which Mr. Broughall had referred, did Mr. Dicken mean that he had no difficulty in obtaining from these cupola charges a variation in silicon content of only 0.002 per cent?

MR. HOUGHTON remarked that, seeing the character of the work required to-day, they could not overstress the supervision and care necessary for the production of sound castings. Referring to the human element, he quoted an instance of a large casting being made for which the men were engaged several hours in building their moulds. On examination of the castings, it was found that in each case there was a crack in a thin wall, which was discovered to be due to rapping and the temperature of the metal. Thus three-quarters of a day was wasted for a simple cause.

The Author's Reply.

THE PRESIDENT, in reply, admitted that he was rather more fortunate than some people, inasmuch as he was on the spot if anything did go wrong. However, he had similar experiences to Mr. Player in having 200 or 300 castings in the shop before the men started machining, and when owing to defects there was delay. He heartily agreed with Mr. Broughall as to co-operation between departments, and said it would certainly make for efficiency and economy. Regarding the limit Mr. Broughall quoted, they would not obtain this on a cylinder casting or a soft casting. Mr. Broughall explained that it was a carburettor casting, not from a metal pattern, but a mahogany pattern, and thousands of them were made.

MR. DICKEN, replying to Mr. Broughall, recalled that he had shown different slides for different purposes: the first one illustrating the human element and excessive rapping, the second a pattern shop error, the third a jig and tool design matter, the fourth dealt with a cylinder, and then he took up the cupola charge. Now this particular charge represented nothing except to point out that different pig-irons went with the steel to bring up the charge. As to pig-iron with 2.74 silicon and steel with 0.50 per cent., he said that the proportion reached 25 per cent. of steel in automobile work for cylinders, and the result was that they obtained a good wearing material, which has to be machined with a maximum limit of 1.6 per cent. silicon. The minimum is unimportant, it should be as low as machining will allow. Replying to Mr. Broughall's next point that semi-steel was totally different in cupola practice from grey iron, Mr. Dicken said it was so far, but the Americans put steel in all their cylinders for automobiles. Ford put in 33 per cent. (Mr. Broughall: Maclain educated him up to that.) Mr. Dicken next remarked that he averaged 19.16 per cent. Touching on semi-steel, 18 years ago by adding steel bolt heads, say 20 per cent. But as to the differences in the silicon content of the mixture shown, he might point out that pig-irons suitable for automobile work were limited in number. He himself believed in blending, and he had obtained good schedule automobile cylinders at 1.35 per cent. silicon day in and day out. However, supposing he altered his pig-iron and used a brand containing, say, 2 per cent. of silicon, the resultant casting would be such that castings would be as hard to machine at 1.65 per cent. They could use pig-iron of the same analysis and obtain a good, useful casting at 1,4 per cent. silicon. (Mr. Broughall: The point I raised was why make it difficult to get 1.6 per cent.) Mr. Dicken replied that his reasons for showing the mixture were to illustrate the different positions of pig-iron which was put into the furnace every day. There was a high silicon metal and a low one, and the mixture showed the importance of time in charging. As he had indicated, in the automobile trade they could not obtain pig-iron, except in one or two brands, which would bring out silicon at 1.4 or 1.3. Accurate timing of charges, as well as accurate mixing, was necessary if one was to secure reliable and regular results, and, of course, the steel scrap should be put in first, seeing that the pig-iron would melt the more readily. To revert to cylinders, he did not think it possible to get automobile cylinders much within a limit of half a millimetre. He fully agreed with Mr. Williams' remarks relative to every core being placed in the mould accurately, and every department required careful watching. It was so easy to get ¼ millimetre difference between the core maker and the pattern. As the mixtures of sand differed, so did the resultant contraction. Sand cores differed in contraction according to the temperature, and they would contract more with ordinary red sand. Replying to Mr. Judd, he might explain that his figure of 0.002 referred to scrap from the charges, but as regards the cupola charges the variation he had obtained was 0.2 per cent. silicon.

NEWCASTLE BRANCH.

At a meeting held on October 27 MR. C. BICKERTON, of Manchester, gave a lecture on "Jobbing Foundry Work from Practical Experience," Mr. James Smith presiding. The major portion of this Paper was printed in our issue of November 30, 1922. The Branch-President announced that the Armstrong College Engineering Society had invited members of the Branch to attend any of their lectures and visits during the session.

In introducing the lecturer, THE PRESIDENT said that, although Mr. Bickerton was a stranger to the Newcastle Branch, they welcomed him as one of themselves, and hoped that he would feel quite at home amongst them. He (the President) knew that it was not an easy matter to give a lecture, especially before such a mixed audience, which consisted of engineers, pattern makers, draughtsmen, moulders, and last, but not least, chemists.

Discussion.

THE PRESIDENT, in opening the discussion, said he thought it had been an interesting lecture, and that they all much appreciated what Mr. Bickerton had said. It was his experience that he could always learn something wherever he went, and he had learned several things from Mr. Bickerton. It was quite evident that the lecturer was accustomed to different classes of work from those common in this district, and he hoped the members would not be afraid to ask questions.

MR. EDWARD SMITH said he would remind the lecturer that their usual method was to bed the grates close on the castings, and, in order to obviate any chance of the sands coming off the grates, they generally used small sprigs. This method seemed easier than putting the grates 2 in. off the plates.

The lecturer had mentioned something else which was not their custom, and that was, when he was running a certain mould in the bottom, he kept the down-right smaller than the inlet into the casting. As a rule, in this district they did the opposite. He did not know what advantage there was, and thought that there would be more difficulty in getting the job clean than with the other method.

He had appreciated all the lecturer had said about box parts. Their experience had been that it was just as well to have splitting plates on the corners of the box parts. He did not think, however, that many of them cut a box when it was new, but waited until it broke before putting on a patch.

In reply, the lecturer said he meant that, by using splitting plates one prevented the box breaking in other parts.

With regard to down gates, much depended upon the style of the casting. He had had castings run in the bottom where the ingates were so much smaller than the down-gates that the metal was forced in, and whatever dross there happened to be was carried far into the mould, instead of being allowed to settle where there was no machined surface. He had generally found that it was satisfactory if the runner box was kept up and the

down-gates were sufficiently large in the top part to keep this full. It was better than allowing the dross to get into the mould. There was the same difficulty with having it 2 in. lower at the runner end.

When talking to moulders it was surprising how many subjects cropped up which they had never heard of. A moulder who had been given a core barrel to make, had finished his mould when he was told by the foreman that he had put in his cores the wrong way. In putting cores into a core barrel, the proper way was to put the large side to the mould, and in taking out the barrel, as it is loosened, the sand falls through. It was similar to the way in which street grates are made. The spaces between the bars are smaller at the top than at the bottom, in order to prevent them getting choked up. He (Mr. Bickerton) had never yet told a man to alter a thing without first explaining why he should do so. The least the older men could do was to give the younger men their ideas, and whatever knowledge they imparted to others, they may be sure it did not diminish their own stock.

Proportions of Runners and Inlet Gates.

MR. M. E. GALLON said, in his opinion the value of a lecture was not what the man said so much as what he suggested, and the thoughts he stirred up in the minds of those who listened. The thought in this case was that all young foundrymen should take a course of machine construction, so that they might know what part of the job had got to be machined, and run it so that it was the cleanest part of the casting.

He thought that the handles ought to be cast on the sides of the box if it had to be turned over. He would like to ask why in one instance Mr. Bickerton advocated a big down-goer and a small inlet gate, whereas in another instance he advocated a small down-goer and a big inlet gate. He, personally, believed in the down-goer being smaller than the inlet gate, providing that the former was sufficiently large to fill the mould at a proper rate. He admitted that if the inlet gates were larger than the down gate, there was not the same force, but, nevertheless, there was quite sufficient to fill the mould.

The lecturer said he was speaking with reference to the receiver when he mentioned the inlet gate being smaller than the down gate, and said the idea was to prevent the dross from entering the mould. In the other instance he had said that the down gates were smaller than the ingates because the runner box had to be kept full, and that was why he advocated what appeared to be opposite reasons.

Size of Whirlgate.

MR. YOUNG said that as the question of keeping dirt out of a casting was a very important one, he would like to know what size of receiver the lecturer would recommend for, say, a 23-ton casting.

The lecturer replied that he had not used a receiver for a casting of that size, his largest being about 6 tons, for which he used a receiver of about 2 to 3 cwt.

Turning Over Deep-lift Jobs.

MR. H. F. CLEMENTS (President of the Junior Section) said he understood Mr. Bickerton to say that, in turning over a job with a deep lift, he shored it up with a plank of wood, but the way he was taught to make a deep lift was as follows:—The grate was placed on about 1 in. of sand, with the centre staple reaching to the bottom of the box, the grate being packed from the bottom of the box with bricks or pieces of iron. A hook was put through the staple, and a bar through the hook, and wedged on top of box, thus making a firm construction.

MR. BICKERTON, in reply, said that he had mentioned in his lecture the packing from grates to the top parts. He usually used screw hooks and fish plates for fastening grate to top box. This was liable to "give," no matter how it was packed. In order to avoid that, he fitted a clamp on the outside of the box which reached down to the lift. From the clamps he packed to the lift with a plank and wedges, so as to prevent the sand cracking and falling off under the strain when turning over.

MR. PAULIN said that the President had mentioned, at the commencement of the meeting, that there were engineers present, and even chemists, but, as a matter of fact, they also had a shipbuilder present. In connection with that, he would like to suggest to the lecturer that in future years, when he was explaining that sort of thing, a few diagramatic sketches would be tremendously useful, because it was rather difficult to follow a rapid sketch on the board unless one was really used to that sort of thing.

Another point was that Mr. Bickerton very properly used foundry language throughout his lecture, but he thought that one needed an interpreter for some of these technical words. In different parts of the country they are used in different ways, and therefore need a little explaining sometimes, especially where there is a mixed audience. He was pleased to notice in the model moulding box which had been passed round that Mr. Bickerton used a really scientific method in the arrangement of some of the cross-bars, but he was sorry this method was not continued throughout the box. He quite realised that Mr. Bickerton could not touch upon every subject, but would have liked him to discuss the advantage of oil-sand cores in preference to that costly method of hanging up sand in the top box.

He was glad to notice that the lecturer exercised a trick which seemed to be in favour now, namely, when asked to make sure that he was not making for porosity in any one part of the casting, he used a densener.

The Chairman had mentioned that Mr. Bickerton's experience was different from that in this district, but the general principles running through most of the difficulties, and the manner in which Mr. Bickerton had overcome them, applied to many of the works here.

Moulding Box Construction.

MR. J. W. FRIER, in proposing a vote of thanks to Mr. Bickerton for his very interesting lecture, said he hardly thought, however, that the title of his lecture was altogether correct. In a jobbing foundry in this district one takes anything and everything, but, from what Mr. Bickerton says, he appears to deal with very big pieces of work. Many of the methods which he had explained were familiar to them, but, on the other hand, a good many were not. The lecturer had spoken about making 15- to 20-ton castings and weighting them down, but that was something they did not deal with in this district. He had also referred to gates, and he (Mr. Frier) wondered if he had ever timed how long it took to fill a mould from a certain sized runner. That would be an interesting subject if Mr. Bickerton came to Newcastle again. When casting in hard sand the motto was "get in the metal as quickly as possible," but that does not always pay. When the lecturer spoke about boxes for jobbing work, he had expected to hear about small work.

MR. M. B. HERBST, in seconding, said the moulding boxes were very suitable for a jobbing foundry, and saved the use of bolts and nuts.

After the lecturer had made a brief reply, the proceedings terminated.

German Experiences with Condenser Tubes.—The A.E.G. Company of Berlin has made during recent years a number of careful investigations with condenser tubes in order to determine the best alloy and the best method of preparing the tubes from the alloy. The tubes in German practice are used either tinned or without tin coating. If tinned, the coat was made before the war from pure tin; during the war and in the first years after the war an alloy of 30 per cent. lead and 70 per cent. tin was adopted for the coat. The practical experiences of the A.E.G. have shown that, besides the composition of the alloy, the manner of producing the tubes is of the highest importance. Especially the surface of the tubes must be well polished, as if there is any unevenness this results in forming nuclei of corrosion. The alloys that gave the best results were the English alloy No. 1 (Admiralty) and the German alloy No. 1 (38 zinc, 62 copper, no tin).

Dominion Alloy Steel Corporation.—This Toronto Company is said to contemplate the erection of a $6,000,000 steel plant at Sarnia, Ontario.

Trade Talk.

THE BLAENAVON COMPANY, LIMITED, have blown in a second blast furnace at their plant.

THE SELBY ENGINEERING COMPANY, LIMITED, have removed to 73, Chiswell Street, London, E.C.1.

THE HYDRO-ELECTRIC DEPARTMENT of Vickers, Limited, is now situated at their works at Barrow-in-Furness.

CONTRACTORS' MACHINERY COMPANY, LIMITED, have moved from 17, Victoria Street, to 7, Lower Grosvenor Place, London, S.W.1.

T. WING & SON, electrical and general engineers, have acquired the business of Goodburn & Company, Clarendon Road, Broadstairs.

MR. J. W. FLOWER has established himself in business as an iron and brass founder at the Riverside Works, Cherry Lane, Marsh Gate, Doncaster.

HALL & PICKLES, LIMITED, propose to erect works and warehouses at Crewe, the site for which extends to some 160 acres. The scheme involves a model village adjacent to the works.

AT NEWPORT DOCKS, the Great Western Railway Company propose installing a 3-unit 70-ton weighbridge, capable of dealing with consignments of long iron billets, etc., loaded on bogie wagons.

THE LONDON COUNTY COUNCIL propose that the reconstruction of Lambeth Bridge should be given priority over other bridge works in the County of London. They propose a bridge 60 ft. in width.

LICENCES UNDER THE Non-Ferrous Metal Industry Act, 1918, have been granted to P. Abraham, 276, Bishopsgate, London, E.C.2, and the Rosyth Shipbreaking Company, Limited, 22, Charlotte Square, Edinburgh.

THE STANTON HOUSING COMPANY, LIMITED, who are associated with the Stanton Ironworks Company, Limited, have already placed the order for the first 50 houses to be built in connection with the Stanton Ironworks and Collieries' housing scheme.

A NEW RESEARCH LABORATORY, lecture room, and museum in the chemistry department of the Birmingham Municipal Technical School has been opened by Sir Robert Hadfield. The funds needed for the work have been provided by local firms, the total of whose contributions exceeded £425.

THE RIO TINTO COPPER COMPANY, LIMITED, have just acquired a large site bordering the River Tees near Cargo Fleet, Middlesbrough, and will erect there new works for the manufacture of copper and by-products. The company, it is understood, will also construct new wharves on the river front.

JAMES RENNIE & COMPANY, metal merchants, Exchange Buildings, Birmingham, have formed a separate company, under the style of Rennie, Thursfield & Company, at the same address, to handle the iron and steel departments of their business. Messrs. H. W. Rennie, J. H. Thursfield and D. Russell are partners in the new firm.

IN CONSEQUENCE of the opposition, the reorganisation scheme of the directors of the Argentine Iron & Steel Company, Limited, has been abandoned. It is now stated that the trustees for the debenture-holders have obtained an order authorising the receiver and manager to complete existing contracts and pay any urgent liabilities occurred since April 20 last, but not to enter into new contracts without the leave of the Court.

BABCOCK & WILCOX, LIMITED, Goldie McCulloch & Company (Galt, Ontario), and Babcock & Wilcox (New York), have organised a new Canadian company to undertake the manufacture of boilers, etc. The name of the company is Babcock, Wilcox & Goldie McCulloch, and the head office and works are at Galt. Mr. R. A. McCulloch is the president, and the directors include Sir James Kemnal, managing director of Babcock & Wilcox, Limited, London.

THE SCHEME AUTHORISED by the debenture stockholders of Workman, Clark & Company, Limited, has now been carried into effect, and the prior lien debenture stock has been issued to the bank as security for such advances as the company may require up to £300,000. All the former directors except the technical directors have retired, and Colonel Sir William Charles Wright, Mr. Peter MacCullum Lang, and Mr. J. H. Stephens, have been elected to the board. Contracts for two new ships have been obtained during the last few weeks.

THE LEEDS FORGE COMPANY, LIMITED, Leeds, have received an important order from the Great Indian Peninsula Railway for the supply of 206 bogie hopper ballasting wagons. The wagons are of a special type designed by the Leeds Forge Company, Limited, for track-ballasting purposes, and are similar to those supplied some years ago to the same railway. In addition to the foregoing, the Leeds Forge Company have during the last six weeks received orders for 350 grain wagons for South Africa and 50 steel coaches for New South Wales. This shows a marked improvement since the reorganisation of the company.

THE GENERAL REFRACTORIES COMPANY, LIMITED, of Sheffield, have secured an order for the export to the U.S.A. of 1,000 tons of fluor spar gravel from the recently opened-out Masson Fluor Spar Mines at Matlock.

THE NEW CRUSHING PLANT of the Conisboro' Cliff Company, Limited, at Conisboro', near Doncaster, commenced operations last week. The company, who work an extensive bed of dolomite alongside the Great Central Railway and produce also flux stone for foundry and furnace use, and crushed magnesian limestone, was founded by Mr. Frank Russell, of the General Refractories Company, Limited, Sheffield. The chairman of the company is Mr. Ernest Newell, of Doncaster, whose firm have designed and manufactured the plant. Mr. C. A. Longbottom, Mr. Fredk. Hopkinson, Mr. W. E. Taylor and Mr. Cyrus Jones are also interested in this new enterprise.

ACCORDING to the business and financial report of the Association of Italian Corporations and the General Confederation of Italian Industries, the steel and metal trades are working on a reduced scale, and feel the adverse reaction of the unsettled international situation. The Piombino works are the only ones now producing pig-iron. On the other hand most of the steel furnaces are at work, with the exception of those at Bagnoli. Activity in the engineering trade has increased, more especially in the shops specialised in railway rolling stock and the minor industries connected therewith. The automobile factories are doing an increased business. Taken all in all the situation is viewed with optimism by the business world. From November 1, 1921, to October 31, 1922, there were 643 industrial strikes, with 479,045 strikers and a loss of 6,892,795 days work. From November 1, 1922, to the end of October, 1923, there have been only 154 industrial strikes affecting 52,254 men, with a loss of 246,125 days work. At the same time unemployment has decreased steadily, standing at 183,144 on July 31, 1923, as compared to 216,287 at the same date in 1922.

Personal.

MR. F. R. BOOTH, for many years manager for Roberts & Cooper, Limited, Brettell Lane Ironworks, Brierley Hill, died recently.

MR. W. WEST has joined the staff of the Sheffield Steel products Company. He was until recently chief metallurgist to Messrs. Thwaites, Limited, of Bradford.

MR. F. W. MILLS, who has resigned his position as vice-president and general manager of the Hadfield-Pennfield Steel Company, Bucyrus, Ohio, U.S.A., has returned to Sheffield.

MR. W. RUDDY, formerly foundry manager of the Grinnell Company of Canada, Limited, Toronto, has been appointed manager of the new malleable and grey iron foundries of André Citroen, Paris.

MR. HAROLD WAY has taken up the position of sales manager to Thos. Marshall & Son, tank, cistern and cylinder manufacturers, etc., Armley Road, Leeds. Mr. Way has been associated with the trade for 26 years.

MR. A. L. JOHNSON, chairman and managing director of Rd. Johnson, Clapham & Morris, Limited, and Mr. A. W. Shaw, of the same company, have returned to this country after a business visit to the United States.

MR. DAVID BAKER, general manager of the Newcastle (Australia) steelworks of the Broken Hill Proprietary Company, Limited, has resigned his position, owing to ill-health, but will continue his association with the company in a consultative capacity.

SIR ROBERT HORNE and Sir W. Charles Wright, directors of Baldwin's Canadian Steel Corporation, leave for Canada next week. Sir J. C. Davies, one of the managing directors of Baldwins, Limited, who was seriously ill, has made a rapid recovery and is now very much better.

MR. E. F. HUNTING, assistant works manager of the Shelton Iron, Steel and Coal Company, Limited, has been presented by the staff with a solid silver tea service on the occasion of his departure to take up the position as works' manager at the Dowlais Works. Mr. S. L. Worton (works' manager) made the presentation.

Wills.

WALKER, E., deputy-chairman of Walker Bros. (Wigan), Limited, Pagefield Ironworks £29,223

COLTART, J., of Newlands, Glasgow, for many years associated with P. & W. McLellan, Limited £13,388

THE DOMINION FOUNDRY COMPANY, LIMITED, are being wound up voluntarily. Mr. S. Laycock, Barclays Bank Chambers, North Street, Keighley, has been appointed liquidator.

Company News.

Davis, Ash & Company, Limited, 15, Grape Street, London, W.C.—Capital £10,000 in £1 shares. Engineers.

Glen Irvine Iron & Steel Company, Limited, 20, St. James's Square, London, S.W.—Capital £10,000 in £1 shares.

T. R. Wright & Company, Limited, Leach Street, Birmingham.—Capital £8,000 in £1 shares. General brassfounders, etc.

Brown, Bayley's Steel Works, Limited.—Profit, £31,777, reducing debit balance £46,844 brought in to £15,067 carried forward.

J. & S. Phillips, Limited, 195, Fazeley Street, Birmingham.—Capital £10,000 in £1 shares. Manufacturers of brass tubes and wire.

Super-Centrifugal Engineers, Limited, Imperial House, Kingsway, London, W.C.—Capital £100 in £1 shares. Director: J. W. Murray.

Glenfield & Kennedy, Limited.—Half-yearly dividends on 4½ per cent. A and 7½ per cent. B preference shares; no interim dividend on ordinary.

Harden Cartwright, Limited, 19, Albion Street, Brierley Hill.—Capital £1,000 in £1 shares. Engineers. Directors: H. Cartwright and W. T. Arkinstall.

Guest, Keen & Nettlefolds, Limited.—Interim dividends, 5 per cent. per annum on first and second preference shares and 1s. per share on ordinary shares, all free of tax.

Wallwork, Smith & Company, Limited, 4, Great Marlborough Street, London, W.—Capital £1,000. General agents for iron founders, mechanical engineers, etc. Directors: H. C. Wallwork and R. R. Smith.

Sheffield Premier Alloys Company, Limited, Naseby Street, Brightside, Sheffield.—Capital £15,000 in £1 shares, to adopt an agreement with J. R. Cruise, B. Foxley, J. Nock, W. Sadler, and E. Sadler. Director: J. R. Cruise.

Kerr, Stuart & Company, Limited.—Net profits, £63,994; brought forward, £13,228; disposable balance, £77,222; preference share dividends, 7 per cent. per annum for year, less tax, £8,400; ordinary share dividends, making with three quarterly interim dividends, 12½ per cent. for year, less tax, £28,750; carried forward, £40,072.

Gazette.

Messrs. B. W. Roberts and W. Hunt, brassfounders, Grange Road, Chester, trading under the style of Roberts & Hunt, have dissolved partnership. Mr. W. Hunt will continue the business under the same style.

The resolution by the directors of the British Hydraulic Foundry Company, Limited, that the company be voluntarily wound up, failed to find the necessary majority at the meeting held for the purpose of considering the resolution.

At the expiration of three months the names of the undermentioned companies are to be struck off the Register of Joint Stock Companies, and the companies will be dissolved:—Allied (Sheffield) Iron & Steel Company, Limited; Anerley Engineering Works, Limited; Bagnall Sheet Metal Company, Limited; Basic Carbonising Syndicate, Limited; Bodicote Ironstone Company, Limited; British Wolfram Company, Limited; Central Machine Tool Works, Limited; Chelmsford Foundry Company, Limited; Consolidated Zinc & Lead Mines, Limited; Dawson Electrical Installations, Limited; Delstar Engineering Company, Limited; Dickinson Engineering Company, Limited; Engineering & General Supply Company, Limited; Erstel Engineering Company, Limited; General Engineering Company (King's Cross), Limited; Hampstead Electrical Company, Limited; Hemingbrough Boring Company, Limited; House & Industrial Smokeless Fuel Company, Limited; Howden Boring Company, Limited; International Mineral Corporation, Limited; Inventors Engineering Company, Limited; Iron & Steel Strip Syndicate, Limited; Liverpool Mechanical Engineering Company, Limited; Mechanical Construction Company, Limited; Metal Tubes & Fittings, Limited; Pit Timber Supply Company, Limited; Pulverised Coal Supply Syndicate, Limited; Reading Iron Company, Limited; Rodney Engineering Company (Liverpool), Limited; South Glamorgan Colliery Company, Limited; "Strowe" Metal Productions, Limited; Synthetic Coal Syndicate, Limited; Thompson Bros. (Engineers London), Limited; Tubex Engineering Company, Limited; Tungsten Products, Limited; Turbines, Limited; U.K. Minerals Development, Limited; Westminster Foundry, Limited, and Whitehall Dockyard Company, Limited.

In the Chancery Division, on October 26, Mr. Justice Astbury heard a motion by plaintiff in the action Moore against Bell and Others for the appointment of a receiver of the Dominion Steel Syndicate—formed to amalgamate the Dominion Steel Corporation, the Nova Scotia Iron & Coal Company and the Halifax Shipyards—into the British Empire Steel Corporation. Mr. Rooke Reeve, K.C., who appeared with Mr. Hunt for the plaintiff, Sir Newton Moore, said the matter was one of very considerable magnitude and importance. The motion was not opposed, but the question had arisen as to whether the syndicate did not consist of such a number of persons as to become an illegal association within the Companies Act. The action was in effect for the administration of the funds of the syndicate, which were under the control of the plaintiff, who asked for the appointment of a receiver with certain special directions. In November, 1920, the shares having depreciated in value, a call of £1 per share was made on all the members of the syndicate. In every case this was paid. In December, 1920, Colonel Morden resigned and Sir Newton Moore was appointed syndicate manager in his place, but by that time all the big operations had been carried through. On December 14 it was explained to the members that a further call of £5 would have to be made. This was paid by the greater number of the members, but it was by reason of the fact that some of them did not pay that the working of the syndicate as originally proposed had become very difficult and practically impossible without the intervention of the Court and the appointment of a receiver. In March, 1921, the amalgamation plan was effected and the purpose of the syndicate came to an end. The amalgamation took the form of a company called the British Empire Steel Corporation, which bought up all the shares of the three companies, and in return for the shares of the Dominion Steel Corporation there was preference and ordinary stock of the British Empire Steel Corporation allotted instead. It had been necessary to bring these proceedings, and his Lordship would have to decide whether the syndicate was an illegal body within the meaning of the Act. All the parties agreed that a receiver of the syndicate should be appointed. His Lordship held that the syndicate did not come within the provision of the Act, which said that no company consisting of more than 20 members should be formed for the purpose of carrying on a business for the acquisition of gain unless it was registered as a company. The syndicate, he said, was not formed for the purpose of trading or making profits, and therefore was not an illegal company. He would appoint a receiver, as requested, with liberty to act at once.

Obituary.

Mr. J. Haley, of Charles Haley & Company, ironfounders, Wakefield Road, Bradford, died on October 26, aged 51. The deceased gentleman was a past-President of the Bradford and District Ironfounders' Association.

Mr. R. Jameson died on Tuesday at Westbank, Stockton. Mr. Jameson was, till four years ago, when he retired, secretary and commercial manager of Dorman, Long & Company, Limited, Middlesbrough. He was 75 years of age.

Mr. G. H. Lawlor, of Furmston & Lawlor, engineers' pattern makers, Birds Hill, Letchworth, Herts, died recently, after a painful illness extending over several months. It is the intention of Mr. Furmston to carry on the business on the same lines and under the same name.

Mr. David Walter Cooper, of Church Hill House, Brierley Hill, who for many years had been a prominent figure in the commercial and public life of the district in which he resided, died at Birmingham after a short illness on Monday afternoon. Mr. Cooper, who was about 66 years of age, was a member of a very old and highly respected Brierley Hill family. He was a half-brother to the late Mr. E. E. Cooper, one of the founders of the well-known firm of Roberts & Cooper, Limited, ironmasters, of which firm he was a director and the secretary, being, in addition to this, head of the Wollescote Galvanising Company, of Brierley Hill.

Determination of Fineness of Powdered Coal.—In conjunction with the Committee on Coal and Coke of the American Society for Testing Materials, methods for making size tests of powdered coal, both by hand and machine sieving, have been formulated by Mr. W. A. Selvig, assistant analytical chemist attached to the Pittsburgh Experiment Station of the U.S. Bureau of Mines, and sent to various co-operating laboratories for trial and criticism. This work will be continued with a view to formulating a satisfactory standard for making fineness tests of powdered coal.

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The improvement already noted in the Cleveland iron trade is, so far, well maintained, with the result that business continues steady, with a fair volume of buying orders in circulation, both on home and export account. In connection with the latter section of the trade it may be noted that the October shipments show an increase of 7,108 tons, the total being 41,935 tons, as compared with 34,827 tons in September. Sales to the Continent were generally better, Germany taking 4,500 tons, France 4,487 tons, Belgium 4,429 tons, Denmark 4,385 tons, Sweden 2,034 tons, Italy 1,750 tons, and Holland 1,379 tons. From the point of view of export business, the recent advance in prices has necessarily had some effect upon inquiry. Buyers abroad, most of whom are suffering from depreciated exchanges, find it proportionately more difficult to finance purchases.

Business in the hematite market on the North-East Coast continues steady, with a stronger tendency in values. The increasing activity in the steel trade is palpably reacting upon the hematite position, and the anticipation of an early settlement of the boilermakers' dispute is an important strengthening factor.

MANCHESTER.—In this centre and the districts surrounding there is now some evidence of increased activity in buying, ironfounders having evidently arrived at the conclusion that little advantage will be obtained in delaying purchases of pig-iron in anticipation of a reduction of prices over the remainder of the year. There are consumers, however, who, taking a pessimistic view of the general position, argue that, if actual demand for castings is no better, then when the stocks of pig-iron are renewed buying will fall off again and will be rather worse than it was before, because the hand-to-mouth buying will cease.

THE MIDLANDS.—In the Birmingham market last week pig-iron demand on the whole was reported somewhat more encouraging, but the improvement seemed mostly confined to forge qualities, which for some time past has been in a depressed condition. Sellers were quoting very firmly at last week's rates, and they were able to book at them and were not forced to shade quotations to secure business, an improvement of shillings on the prices recently obtainable. Smelters are now inclined to "go steady" and not rush matters either in booking contracts or fixing prices.

SCOTLAND.—In confident anticipation of an early settlement of the boilermakers' dispute, the tone of the Scottish pig-iron markets shows the improvement recently noted to be well maintained, with some evidence that business will continue to broaden out. The improvement, meantime, is confined to the home market and, as far as pig-iron is concerned, the makers here are anxious to foster the better tone by keeping prices within reasonable limits, so that whilst quotations are firmly held there is no advance to report, although the price of Scotch, viz., 102s. at furnaces, is still very much below that of Middlesbrough, which is quoted at 107s. at Grahamston. Quite unexpectedly No. 3 Continental iron was offered last week at 102s. 6d. at Grahamston, but only small parcels seem to be available. The quantity of Continental pig-iron brought into Scotland last month was under 2,000 tons.

Scrap.

Corresponding with increasing activity in markets for raw materials generally, a similar movement may be noted in the scrap metal trade, in which a firmer all-round tendency is reported, with the exception of non-ferrous material. In the case of steel scrap, the very low prices of the early autumn have disappeared, and in South Wales and Sheffield much higher prices are being paid. Up to 90s. per ton is now quoted in Wales for ordinary heavy steel melting scrap, and the Sheffield consumers are coming near to this price. Lancashire ironfounders are not taking cast scrap very freely yet, but they have been buying much more freely in the pig-iron market, and dealers think that they will soon have to buy scrap for mixing purposes. The prices for cast scrap are higher than they were, and for the best qualities up to 90s. per ton has been paid, but there is still a large quantity of common cast scrap about at 80s. per ton.

Metals.

Copper.—During the past week the market for standard copper has experienced a steady upward movement, stimulated, doubtless, by more buoyant reports of some active buying by American interests. There seems to be a growing impression that the worst of the depression has been seen, since it is assumed that American low cost producers have already disposed of a large portion of their old accumulations and are now less anxious to press sales at current prices on the basis of about 12¾c. per lb. Current quotations :—*Cash* : Thursday, £61 17s. 6d. ; Friday, £62 10s. ; Monday, £62 15s. ; Tuesday, £62 12s. 6d. ; Wednesday, £63 5s. *Three months* : Thursday, £62 10s. ; Friday, £63 2s. 6d. ; Monday, £63 5s. ; Tuesday, £63 15s. ; Wednesday, £63 5s.

Tin.—In the standard market for tin recent developments have disclosed a decidedly active trade demand, and this, combined with a sound statistical position, has resulted in strengthening values to a remarkable extent, quotations taking a sharp upward turn last week, reaching a figure over £220 for cash.

Current quotations :—*Cash* : Thursday, £214 5s. ; Friday, £214 10s. ; Monday, £217 ; Tuesday, £221 ; Wednesday, £220 7s. 6d. *Three months* : Thursday, £214 5s. ; Friday, £214 10s. ; Monday, £217 ; Tuesday, £221 ; Wednesday, £220 7s. 6d.

Spelter.—The market for this metal has of late taken a quieter turn, with prices showing a slightly lower tendency. Demand on the part of consumers has been only moderate, but is expected to improve. On the other hand, producers make no effort to effect sales, and sellers generally adopt a rather reserved attitude. The future of the market is viewed with rather more confidence, and as dealings are now taking place well into the New Year, buying seems likely to expand. Current quotations :—*Ordinary* : Thursday, £32 11s. 3d. ; Friday, £32 17s. 6d. ; Monday, £33 7s. 6d. ; Tuesday, £33 10s. ; Wednesday, £33 7s. 6d.

Lead.—Business in soft foreign pig of late has been fairly steady, with prices showing a slight reaction. Subsequent to the adjustment of October contracts, which caused a good deal of manipulation, prompt metal finally showed a slight loss, although forward delivery gained fractionally on balance. Current quotations :—*Soft foreign (prompt)* : Thursday, £30 ; Friday, £30 15s. ; Monday, £31 2s. 6d. ; Tuesday, £31 2s. 6d. ; Wednesday, £31.

We regret to announce the death of Mr. T. B. Kittel, a director of the Frodair Iron & Steel Company, Limited, and Kittel & Company, Limited.

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